EFFECTIVE SCIENCE TEACHERS’ PROFESSIONAL DEVELOPMENT: A MULTIPLE-CASE STUDY OF DISTRICT-LEVEL SCIENCE SUPERVISORS’ PERSPECTIVES

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EFFECTIVE SCIENCE TEACHERS’ PROFESSIONAL DEVELOPMENT: A
MULTIPLE-CASE STUDY OF DISTRICT-LEVEL SCIENCE SUPERVISORS’
PERSPECTIVES

by

Chris Jay Schaben

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EFFECTIVE SCIENCE TEACHERS’ PROFESSIONAL DEVELOPMENT: A MULTIPLE-CASE STUDY OF DISTRICT-LEVEL SCIENCE SUPERVISORS’ PERSPECTIVES

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University of Nebraska, 2011

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At its heart, science teachers’ professional development is about continual growth and improvement (Yager, 2005). Conducting research to understand what constitutes effective professional development is inherently complex (Hewson, 2007). The imperative to link research on professional development to student achievement (Fishman, Marx, Best, & Tal, 2003) increases complexity of research on the topic. These complexities require multiple research approaches and indicate that all stakeholders could provide insights to identify what constitutes effective professional development. District-level science supervisors’ voices are missing from the data on effective science teachers’ professional development and this provides a potential gap in the literature (Banilower, Heck, & Weiss, 2007; Elmore & Burney, 1999; Shroyer, Miller, Hernandez, & Dunn, 2007).

The purpose of this multiple-case study was to gather information from six district-level science supervisors from six different school districts in six different states to gain a deeper understanding of their insights on what constitutes effective professional development. The empirical data examined in this study resulted from interviews, participant drawings, observations, and document review. The major finding was that the
district-level science supervisors mostly confirmed what was known in the field. However, this finding could be used in a variety of ways to support future research; such as providing a potential data source to corroborate self-reported teacher survey data. The findings from this study also identified a few nuances to what is known about effective science teachers’ professional development research. Specifically, a finding suggests that researchers may need to reconceptualize the amount of time before which science teachers’ professional development can impact student achievement. Another nuance identified relates to the, already known, understanding that district-level science supervisors’ beliefs (Borman, 2005) and position power can impact their actions (Spillane, 2000). This nuance suggests that district-level science supervisors may desire that the teachers in their districts teach as they taught. If so, future research should identify what teaching approaches the district-level science supervisors utilized when they were teaching.
DEDICATION

To my children and all students,

when the opportunity presents itself may you choose to try.
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Thank you to my family and friends for all of their support and encouragement. I thank God for their presence in my life and for enabling me to complete this humbling process. A very special thank you goes to my wife Elizabeth who has supported me with great devotion. She has consistently made all things possible and her actions have provided time for me to complete my degree requirements. This was against the backdrop of my concurrent fulltime employment and building a family together with four wonderful children. So undying is her devotion that she didn’t even flinch when I briefly joined the active ranks of the United States Air Force, nor when I took on the duties of the office of the President of the Nebraska Academy of Sciences during this time period. Rather, she has been a constant champion for my choices and endeavors. I am truly blessed to have her in my life.

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CHAPTER 1

Science Teachers’ Professional Development

Introduction

Because societal hope hangs on the success of schools, there has been a constant drumbeat to improve schools with much of the focus centering on teachers’ professional development as one tool practitioners utilize to improve schools (Perry, 2004). As such, it is imperative that effective professional development be understood. Further, it is especially important to understand effective science teachers’ professional development, as science education is critically important to the future of the United States (Bybee & Stage, 2005). This chapter will explore current understandings of science teachers’ professional development and, in doing so; identify potential gaps that frame the purpose of this study.

This study builds upon the assumption that science education has some relevant and commonly held understandings regarding: (a) K-12 science education, (b) current guiding forces for science education policy, and (c) effective science teachers’ professional development. The next sections of this chapter will explore these assumptions so that the gaps in contemporary knowledge of science teachers’ professional development can be evaluated.

**Understandings of K-12 science education.** At the national level, science education has been grounded in seeking standards for content, teaching, and professional development in K-12 education (National Research Council, 1996). Organizations such as the American Association for the Advancement of Science (AAAS) have provided significant direction for establishing a vision of what science content belongs at different
grade levels with publications like the *Atlas for Scientific Literacy* (American Association for the Advancement of Science, 2001) and the *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993). Recently, state governments have also become active in establishing a national set of science content standards (Phillips & Wong, 2010). While it is impossible to predict what will happen, it is likely that this increase in attention will lead to funding to establish and implement these new content standards. One only has to look historically at the response to *A Nation at Risk* (National Commission on Excellence in Education, 1983) where the science education community invested heavily in science and teaching science as fears were raised about falling behind as a nation. Professional development will be the likely vehicle to implement changes following revision to content standards.

**Understandings of science education policy and its impact on change.** Since public schooling was established in the United States, an untold number of national, state and local polices have been enacted. Every policy was intended to exact positive change; however, policy implementation has had mixed results. Consider how public education interpreted and implemented policy based on *Plessy vs. Ferguson* where “Separate but equal” was initiated in educational settings with disparaging results for significant numbers of children (Holzman, 2008; Jackson, 2008; and Kinshasa, 2006). It is possible that well-intentioned science education policy makers could enact laws that go astray as well.

Science education policy in public schools is often initiated by political rhetoric and ensuing funds. Whether the political rhetoric incites fear or optimism for school improvement, politicians often proclaim to be the only candidate truly concerned about
education and will craft educational policy to implement their perceived needs for change when it is, in reality, to their political advantage. Brown (2004) highlighted an extreme example: “The executive branch of government represented by the President of the United States gets involved in public education when it is to his political advantage” (p. 191). When politicians involve themselves in science education, their rhetoric shapes policy that initiates the desire for change and accountability in schooling, which requires funding to materialize (Daniel, 2004). While some hold that curriculum, standards, and assessment can cause positive change for schooling, according to Perry (2004) the chief vehicle to exact change in education is professional development.

Research-based demands for change in science education coerce school districts to require modifications in teachers’ practices and content knowledge. For example, the changes suggested from Cohen, Finn, and Haycock (2004) that related to the shortcomings of the standards movement were to increase science curricular requirements. Their view concluded that “The next step [to correct the shortcomings of high stakes tests] is to keep ratcheting up, not lowering, requirements” (p. 38). It would be difficult for districts to increase curricular requirements in public schools without an increase in funding (e.g., hiring more teachers, training more teachers, implementing more curriculum and materials, etc.). For example, the United States government spent approximately $1.5 billion on professional development in one school year for Title I and Title IIA, which represents a national investment. This large of an investment to change teaching practices through professional development prompts the desire for more complete understandings of professional development (Birman et al., 2007).
Understandings of effective science teachers’ professional development. The understanding of what constitutes effective professional development improves as research on this process is undertaken (Elmore & Burney, 1999). The National Staff Development Council (NSDC) espoused [emphasis added] that effective professional development must be results driven or related to process, standards embedded or related to content, and job embedded or related to context (National Staff Development Council, 2001). Argyris and Schön (1974) identified two types of theories: espoused and theories-in-use. The word espoused is used in reference to the NSDC’s staff development standards as they explicitly describe the necessary components of effective professional development Argyris and Schön (1974).

Two recent studies interpreted the NSDC’s three ideas differently but still related them to their research to show how the NSDC’s staff development standards can also be thought of as theories-in-use (Argyris & Schön, 1974). Consider that Blank and de la Alas (2009) interpreted the important tenets of professional development to mean that effective professional development must sustain over time, relate to content knowledge, and employ active methods of teacher learning. Another study from Banilower, Heck and Weiss (2007) argued that effective science teachers’ professional development takes place when participants are active learners, professionals, and apply learning to classroom practice. The studies of professional development by Blank and de la Alas (2009) and Banilower et al. (2007) show that the NSDC’s standards regarding effective professional development can be thought of as both espoused and theories-in-use (Argyris & Schön, 1974).
The National Science Education Standards (NSES) provided another set of criteria for effective professional development (National Research Council, 1996) that relates to the National Staff Development Council’s (NSDC’s) three core understandings regarding effective professional development (National Staff Development Council, 2001). Figure 1.1 demonstrates the relationship between these two understandings.

Figure 1.1. A graphic representation of the relationship between the National Science Education Standards (National Research Council, 1996) and the National Staff Development Council’s understandings of effective professional development.
Figure 1.1 shows the NSDC’s three core understandings as corners of a triangle with each understanding within one of the overlapping circles. Layered within the circles are the four NSES standards on professional development as represented by letters: a, b, c, and d. The NSES professional development standards may be thought of as:

(a) continuous inquiry, prior knowledge or learning science; (b) integrating content, pedagogy, and students or learning to teach science; (c) life-long learning with feedback and reflections or learning to learn; and (d) continuously coherent and integrated or quality programs at all levels (National Research Council, 1996). Figure 1.1 intends to represent that learning to teach science is central to effective professional development and illustrates that learning science and quality programs at all levels is inevitably linked to the NSDC’s core understanding that context and content are paramount for effective professional development.

**Relating the Present Study to Current Understandings**

This study will evaluate how district-level science supervisors perceive the common understandings of effective professional development by explicitly adding their voice to the research. The district-level science supervisors in this study offer unique perspectives regarding science teachers’ professional development: they had experiences with developing, initiating, responding to, implementing, and evaluating professional development for science teachers in their respective districts. It stands to reason that with these experiences with science teacher’s professional development that the district-level science supervisors represent a group whose perceptions add significant value to current understandings. At a minimum, findings from studies of district-level science supervisors could inform research on professional development of practicing teachers.
Keys and Bryan (2001) made a parallel argument that research to promote effective implementation of reform through professional development in science classrooms must be done in “resonance” with the teacher’s voices because “Teachers’ once muted voices will be raised loudly and clearly in the call to reform” (p. 642). District-level science supervisors’ voices are also muted but should be considered important because they will add to understandings of teachers’ professional development since they are in prime positions to work with teachers and observe teacher change.

**District-level science supervisors’ muted voices.** Banilower, Boyd, Pasley, and Weiss (2006) conducted a landmark, longitudinal study of effective professional development; the focus of their work was to “Provide some insights into topics relevant for other large-scale reform efforts” (p. 5). Their review of a decade of reform efforts indicated that the most effective professional development programs have duration of at least 80 hours. Though this and other research can offer important contextual insights, research on professional development has not availed itself of the opportunity to understand science teachers’ professional development from district-level science supervisors’ perspectives. This is puzzling given that Banilower et al. (2006) acknowledged that administrators are important to professional development and that it is necessary to capitalize on their position and leadership. Specifically, they stated, “Mid-level administrators [including district-level personnel] often proved to be the strongest and most stable allies, and local systemic change initiatives (LSCs) should capitalize on the position and leadership of these individuals” (p. 72).

If it is understood that LSCs should capitalize on the strengths of the district-level science supervisors, then it follows that research ought to be conducted to better
understand the perspectives of this group, what they feel they can offer, and what challenges they face. A more comprehensive approach needs to explicitly gather data to understand district-level science supervisors perspectives on the effectiveness of professional development. On the surface, it appears that Banilower et al. (2006) attended to science supervisors’ missing voices; however, in the section of the report specifically written about district administrators, data on district-level curriculum supervisors was aggregated together with other administrators: along with the district-level curriculum supervisors, they included superintendents, school board members, Title II staff, and other informants in their data. This dilutes the unique perspectives of the district-level science supervisors and fails to offer an understanding of the unique role they have in the implementation of reform.

Other researchers have also missed opportunities to understand what district-level science supervisors have to offer. For example, Shroyer et al. (2007) did not explicitly bring forward district-level science supervisors’ voices and provides another example of research that missed an opportunity to include the supervisors’ voices. The purpose of the Shroyer et al. (2007) study was to “demonstrate the impact of long-term professional development and systemic reform on K-16 science teaching and learning” (p. 4). At least for the K-12 portion of the system, the district-level science supervisors had potentially key understandings of the professional development efforts within the systemic reform, but their voices were muted as Shroyer et al. (2007) chose not to focus on their insight.

Borman (2005) argued that the school context and the entire community is a critical variable in understanding the effectiveness of professional development. Borman (2005) made a strong case that examining data from administrators would facilitate better
understandings of the school context in which schools undertake reform, and she interviewed principals for the data on an administrative perspective. Similar to the case that Borman (2005) made for studying data from principals, researchers could also obtain data from the district-level science supervisors to complement current understandings of science teachers’ professional development. Thus, in all three studies presented in this section, the researchers missed opportunities for deeper understanding of effective professional development by choosing not to include the district-level science supervisors’ voices.

As district-level science supervisors’ roles often include responsibility for developing, initiating, responding to, implementing, and evaluating professional development for science teachers, this group’s voice is significant and should be studied to better understand science teachers’ professional development. The district-level science supervisors are a key group of individuals in public education, as they both know what is on reform agendas and are responsible for seeing that policy reified into practice within local contexts. This detailed understanding of local schooling represents an untapped resource that can be mined to add to understandings of professional development.

**The need for broader, district-level studies.** Even though there are studies regarding specific professional development programs and single curricular implementation efforts, there are few broader and comprehensive studies regarding what constitutes effective science teachers’ professional development, which is worrisome for practitioners (Lord, 1994). Science teachers’ professional development research is difficult to conduct because there are multiple and complex variables. In a chapter on
professional development in the *Handbook for Science Education Research* (Abell & Lederman, 2007), Hewson (2007) defined these complexities for researchers and summed up the phenomenon: “The short answer is that it is complicated and difficult, because the object of study—teacher professional development in science—is itself inherently complex” (p. 1182). Since studying science teachers’ professional development is complex, it is important to study all aspects including the district-level science supervisors’ collection of experiences in addition to studying specific programs or curriculum implementation efforts.

As a means of assessing the effectiveness of science teachers’ professional development on a broad scale, few studies have emerged. Most professional development studies have focused on understanding the effects of a single program or the implementation of a curriculum or instructional strategy in one location. Elmore and Burney (1999) stated, “Although we know a good deal about the characteristics of good professional development, we know a good deal less about how to organize successful professional development so as to influence practice in large numbers of schools and classrooms” (p. 263). One way to learn about how to organize successful professional development on a large scale is to seek broad understandings of effective professional development by examining district-level science supervisors’ perceptions of professional development.

**District-level science supervisors have multiple roles.** The district-level science supervisors may assume multiple roles because they serve as the facilitators in a complex, somewhat anonymous administrative structure. It is the district-level science supervisors who initiate, develop, implement, and deal with outcomes of specific
professional development offerings (McComas, 1993). If they perceive these as beneficial, they can become active and passionately engaged. Other times, district-level science supervisors become the coerced facilitators of professional development offerings forced upon teachers in their districts. Both roles can occur during the implementation efforts of national, state and local initiatives (McLaughlin, 1987). The role the district-level science supervisors assume ultimately impacts the fidelity of implementation of policy; therefore, their perceptions of professional development deserve study (Burch, 2002).

**Bracketing the Researcher’s Beliefs**

Moustakas (1994) recommends that the qualitative researcher bracket his preconceptions. He admits that sometimes life experiences are so ingrained that it is sometimes nearly impossible to abandon all preconceived ideas. This can serve as an entry for bias in qualitative research; however, measures can be taken to diminish that bias. More information on this limitation is covered later, but one way to reduce this bias is to reveal the researchers background instead of pretending that it does not exist (Moustakas, 1994). To that end, the researcher for this study is a district-level science supervisor for an urban public school system with approximately 50,000 students.

Bolman and Deal (1997) have identified that organizations’ structures are complex and what is happening within them is not always easily discernable. Tyack’s (1974) position that schools organize themselves into different structures suggests another wrinkle that can hinder understanding. However, there are some commonalities in in the job of district-level science supervisor in that they often have similar responsibilities (McComas, 1993). So, even though districts’ personnel structures vary (Tyack, 1974),
the researcher often found many educational professionals with like-jobs at professional science teacher and leadership conferences. He also believes that connecting with this group is extremely helpful in giving guidance to more successfully execute his job. Given this belief, he was puzzled not to find their voice among the literature. Enter this study. With the researchers concurrent experience as a district-level science supervisor he is more keenly aware of the missing or overlooked supervisors’ voice in the literature, which led him to this inquiry.

**Purpose Statement**

The purpose of this multiple-case study was to gather information from six district-level science supervisors to gain a deeper understanding of their insights on what constitutes effective professional development. The data collected in this study resulted in a set of emerging themes and findings related to what constitutes effective science teacher professional development and suggestions for future research. These emerging themes and findings augment the *National Science Education Standards* (NSES) for professional development of science teachers (National Research Council, 1996) by serving as a starting point for understanding how the district-level science supervisors perceive and describe effective professional development.

The following points are further discussed in Chapter 3, but interviews, artifacts, observations, and participant drawings of effective and ineffective professional development from the district-level science supervisors serve as the empirical data points for this study. These data are appropriate to gather and analyze, as the study’s focus is to explore the perceptions of the district-level science supervisors as a novel group for inquiry (Merriam, 1998). The researcher is confident of these decisions given that
consensual understandings exist for what constitutes effective professional development, but how those understandings work in real situations for real students can be varied (Elmore, 2002). So, in a seminal way, this study asks district-level science supervisors about their perceptions of effective science teachers’ professional development.

**Research Questions**

The central research question for this study was: What can district-level science supervisors add to the understandings of effective science teachers’ professional development? Sub-questions included:

1. How do district-level science supervisors perceive and describe their experiences with teachers’ professional development?

2. What value do district-level science supervisors ascribe to their experiences with professional development for science teachers?
   a. How do district-level science supervisors define effective professional development?
   b. How do district-level science supervisors define ineffective professional development?

3. What can district-level science supervisors tell us about the origins, intended goals, or visions for science teachers’ professional development versus the actual outcomes of science teachers’ professional development?
   a. In what ways can the barriers to effective professional development for teachers be overcome?
Significance of the Problem

Professional development is the vehicle for change in public education (Perry, 2004). Impacting change in science education through professional development costs stakeholders through salaries, substitute teachers, materials and funds to support partners. The NSES (National Research Council, 1996) provides clear direction for science teachers’ professional development; however, the published literature provides little about how effective science teachers’ professional development actually plays out in real situations within multiple and complex contexts (Burch, 2002; Elmore & Burney, 1999; Hewson, 2007; Lord, 1994; McLaughlin, 1987). Studying the science supervisors’ perspectives will add to the understandings of how organizational context can support the implementation of effective professional development.

Limitations

As previously mentioned, understanding professional development is difficult because it involves a complexly interrelated system of personal learning, and at times, learning about learning (Hewson, 2007). So too are the experiences of the district-level science supervisors complex as they are a part of complicated and heterogeneous district structures (Burch, 2002). However, they need be studied because of their key position to influence the quality and effectiveness of professional development. Due to these complexities and the scarcity of research, the researcher chose to begin with fundamental questions as a starting point in this study to better understand science teachers’ professional development. Thus, a limitation in this study is that only fundamental questions will be addressed in a limited set of individuals, and this leads to a partial
insight that may or may not be generalizable. As previously mentioned, there is also the opportunity for researcher bias given the background experiences of the researcher.

Chapter 3 will discuss the following issue further, but another possible entry for bias in this study is visible when discussing how the researcher gained access to the sample for this study. The researcher found five out of the six participants at professional conferences or in professional meetings that he also attended. This fact allows for bias to enter as the participating district-level science supervisors in this study were mostly those who valued the professional conferences and meetings enough to participate in them. Thus the district-level science supervisors’ perspectives may be limited to those who find value in attending professional meetings. District-level science supervisors who are not inclined to attend professional conferences or those who attended professional conferences different from the researcher may have responded differently.

**Definition of Terms**

*Context*—Context is a term that the National Staff Development Council (NSDC, 2001) uses to describe necessary elements of staff development that are job embedded. The professional learning is a part of what the employee does versus being seen as an add-on experience or requirement outside of normal work duties.

*Process*—Process is a term that the NSDC (2001) uses to describe professional development standards that are results driven in that the organization uses disaggregated student data to determine professional learning goals, monitors progress towards goals, and seeks continual improvement.

*Programmatic Research*—Programmatic research is the term the researcher uses to describe professional development research that is based on a program. The research
evaluates the program or seeks to understand the fidelity of implementation. That is, the degree to which the goals of the program or professional development experiences are implemented in the classroom post experience.

*District-Level Science Supervisor*—Public school districts have a variety of administrative structures, in which each level of personnel within the structure is able to influence reform efforts (Supovitz, 2008). The heterogeneity of districts is somewhat minimized in this study as the individual cases include districts of similar size. In this study, the district-level science supervisor is the person in the central office who is responsible for maintaining curriculum, facilitating the adoption of new materials, communicating with the local board of education regarding science matters, observing teaching practices, evaluating teachers, and has one or more levels of administration between her and the district superintendent. The district-level science supervisors in this study also have support persons including a secretary and lead teacher(s).

*Science Lead Teacher*—Public school districts have a variety of structures of personnel beyond the classroom (Tyack, 1974). Some districts assign supporting teachers to assist the district-level science supervisor in his/her responsibilities who do not have classroom teaching responsibilities. These positions are either funded by grants or by the general budget. Some districts will label these positions as a science coach or science lead teacher. For this dissertation, the teachers assigned to assist the district-level science supervisor who do not have classroom duties will be referred to as science lead teachers.

*Professional Development Partners*—These are individuals who support school districts and district-level science supervisors in a variety of ways in their delivery of
science teachers’ professional development. This group could include university professors, commercial vendors, or informal science partners such as zoos, museums, aquariums, and philanthropists.
CHAPTER 2

Literature Review

Introduction

The focus of this study was to understand effective science teachers’ professional development from an analysis of district-level science supervisors’ experiences in six public school districts. Importantly, there are limited published studies on science teachers’ professional development (Blank & de la Alas, 2009; Hewson, 2007; Lord, 1994). In addition, the available research has often overlooked the complexity of science teacher’s professional development by excluding relevant constituencies including district-level science supervisors (Banilower, Heck, & Weiss, 2007; Elmore & Burney, 1999; Shroyer et al., 2007). Further, the studies that have contributed to understanding teachers’ professional development have often been limited to a program evaluation or a specific curricular implementation effort. This underscores the need for broader studies that consider the process and context of professional development (Lord, 1994).

Chapter 1 outlined the case for undertaking research to understand district-level science supervisors’ perspectives on effective professional development within the complex contexts (Hewson, 2007). This chapter will build upon the understandings of effective professional development presented in Chapter 1 by discussing the history and importance of science education and science teachers’ professional development, examining the role of the district-level science supervisor, and reviewing a few recent studies that identify the theoretical basis for methodological design issues and decisions utilized in this study.
History and Importance of Science Education and Science Teachers’ Professional Development

As argued in Chapter 1, the Staff Development Standards (National Staff Development Council, 2001) and the National Science Education Standards (National Research Council, 1996) helped to shape understandings of what constitutes effective science teachers’ professional development. The argument was also made that there is a need to study science teachers’ professional development from a broad perspective, and include one group whose voice has been absent from the current body of research, the district-level science supervisors. To understand why this is important, the first portion of this chapter will briefly review the history of science education and science teachers’ professional development, and examine the role of district-level science supervisors.

Though public education in the United States is remanded to the states by the Constitution, the federal government has been influencing public education by supplying some level of funding since 1917 (Atkin & Black, 2007). American science education has been shaped by numerous other factors. One example is the Committee of 10 in 1893 who recommended that science in secondary schools should occupy 25% of the curriculum (Atkin & Black, 2007). Another example is the Physical Science Study Committee in 1955 who pushed curriculum to include science topics and courses with a timely basis in scientific research (Atkin & Black, 2007). However, no single event had a greater impact on science education in American public schooling than the 1957 Soviet launch of the satellite Sputnik. Atkin and Black (2007) stated, “No other curriculum movement in science so centrally involved the nation’s most accomplished scientists in work at elementary and secondary-school levels as those that flowered from 1955 to the
early 1970’s” (p. 791). In addition to the scientists’ interest in elementary and secondary science education, the public also invested heavily in new science curriculum during this period (e.g., the formation of the National Science Foundation in 1950). As mentioned in the previous chapter, there have been more recent politically charged attempts to motivate public interest in education with specific connections to science (e.g., *A Nation at Risk Report*, *Goals 2000*, *America Competes Act*, *Rising above the Gathering Storm*, etc.), but they have never gained the same traction as the response to Sputnik did.

The response to Sputnik, with the heavy investment of public funds in science education, is evidence that the United States views science education as vital for maintaining its democratic freedoms and values (Hazen & Trefil, 1991). Further, Schwab (1978) posits that science education not only offers students opportunities to understand principles and connections among them, but also provides the student with a skill set to understand and make sense of new situations that he encounters after formal schooling. Thus, science education is important overall to the nation and to the individuals within the nation as they comprise and make stronger or weaker the nation.

Along with the national interest in science education and its curriculum spawned by Sputnik, a simultaneous interest emerged in the field of how to best teach science. Abell (2007) outlined the progression and importance of “Pedagogical Content Knowledge” (PCK) by tracing the beginnings of PCK back to Schwab’s work in the 1960’s with subject matter knowledge. Abell (2007) further posits that Shulman built upon Schwab’s work in 1986 by defining PCK as “The knowledge that is developed by teachers to help others learn” (p. 1107). The development of PCK in the science field is important because it represents a formalization of the understanding that teachers and
their abilities are very important to effective science teaching. It led to the understanding that professional development deserves study (National Research Council, 2001).

The standards movement provided the basis for identifying the specific criteria for effective professional development (Elmore, 2002). Chapter 1 examines the standards that were most influential in science teachers’ professional development, the National Science Education Standards (National Research Council, 1996), in relationship to the broader understandings that effective professional development concerns itself with content, context, process (National Staff Development Council, 2001) (see Figure 1.1). Fishman et al. (2003) also pushed for researchers to link student achievement to research on the effectiveness of professional development. When the parameters of effective science teachers’ professional development presented in Chapter 1 are coupled with the charge to study teachers’ professional development by the National Research Council (2001), the question follows: Who has responsibility for executing science teacher professional development? Several people have different levels of responsibility in executing professional development for science teachers. Among others, these are district-level science supervisors, human resource officers, lead teachers, principals, staff development officers, and superintendents. This research seeks to learn more about what the district-level science supervisors have to offer. The researcher belongs to this group and noticed that this group’s voice was not well represented in the research on what constitutes effective science teacher professional development.

The Role of the District-Level Science Supervisor

The district-level science supervisor can be best described as a “Street-level bureaucrat” within the urban public schools because they must operate with limited
resources yet find ways to accomplish the demands of the system while adhering to all levels of policy (Wheatherly & Lipsky, 1977). Tyack (1974) revealed how the urban public school systems in the United States came to have and almost require positions such as the district-level science supervisors. He argued that throughout the 19th century while the cities were growing and industrialization was shaping the United States because of economic and social necessities, education began to “Systematize” schools to create a hierarchical system; “In short, they tried to create a more bureaucratic system” (p. 29).

With the creation of a more bureaucratic education system, more positions were generated that were poised to help or hinder learning in urban public schools. Darling-Hammond (1997) held disdain for this bureaucratization of the urban education system and suggested that a complete restructuring of the school organization would be necessary where the resources and capital held at the district level should be redistributed to the school level. While restructuring may be necessary, the reality is that current urban education systems remain bureaucratic with multiple layers of administration. Borman (2005) understood that reality and identified three different categories for the district-level administrative positions as superintendents, curriculum supervisors, and officials and directors of National Science Foundation programs. Borman (2005) believed that the district-level positions were important because the administrators possessed the power to influence policy and because of their ability to affect the success of reform initiatives.

Borman (2005) described how the district-level supervisors’ role situated them uniquely between policy mandates and implementation and discussed how the district-level administrators would both help plan and implement professional development. Borman (2005) was not as concerned with a complete restructuring of school systems as
was Darling-Hammond (1997) and obtained data indicating that the district-level is important. She was troubled by finding from interview data that district-level administrators generally did not view themselves as primarily responsible for reform implementation. This interview data revealed that district-level administrator’s self-view was important and held the potential to impact science education.

Spillane (2000) also viewed the district-level leadership positions as an essential yet under-researched component of reform efforts because. He believed that the successful implementation of curricular reform depended somewhat on the “broader policy environment in which classrooms were nested” (p. 142). As Spillane (2000) examined reform in mathematics and the role of the district-level supervisors, he found that how the district-level supervisors understood the reform had an effect on how well the reform was implemented. Thus, alterations to the district-level science supervisors’ self-view of responsibility for reform (Borman, 2005) and the district-level science supervisors’ understandings of reform efforts (Spillane, 2000) both hold potential to impact reform efforts.

**Review of Recent Research**

The studies included in the following section of this chapter were identified by search in EBSCO and JSTOR through the University of Nebraska’s on-line library system. A key word search included the terms science, teacher, public, education, supervision, and professional development. The search was limited to scholarly articles published after 2000 to find recent studies that could have been informed by Spillane’s (2000) work, and the researcher reviewed the abstracts of the articles from the search to find studies related to science teacher’s professional development. The researcher also
presented initial ideas pertaining to this dissertation at the Student Research Conference at the University of Nebraska-Lincoln. During the question and answer portion of that presentation, the researcher received fruitful input from peers and professors including the suggestion to review the Blank and de la Alas (2009) report, which was based on a meta-analysis of mathematics and science teachers’ professional development research. Finally, the researcher also reviewed articles that were cited in the Blank and de la Alas (2009) report to find other potential recent research studies for review.

The relevant research could be organized into two groups: studies that focused on learning about professional development based on a specific curriculum implementation or reform effort, and studies that were broader in scope and sought to learn about professional development that was not based solely on one reform or curriculum implementation effort.

The researcher did not find any studies that solely studied district-level science supervisors’ understandings of professional development. The ten works reviewed and presented in this chapter were selected because they were examples that met their goals, contributed to understandings of professional development, and contained particular design elements consistent with effective research practices as defined by Creswell (1998) and by Merriam (1998). The first few studies reviewed here have broader perspectives. Then studies focusing on a specific reform or curriculum implementation effort are reviewed. Finally, this chapter presents two research studies of professional development studies in mathematics and English that contain relevant methodological designs. These support the contention that science supervisors’ understandings of teachers’ professional development may be obtained by utilizing a case study design
(Creswell, 1998; Merriam, 1998), and provide important theoretical underpinnings for the following chapter.

**Broad-Based Studies on Science Professional Development**

Given the scarcity of research on science teachers’ professional development, the Blank and de la Alas (2009) meta-analysis represents a hallmark in providing insight into how to provide effective science teachers’ professional development. Blank and de la Alas (2009) reviewed 416 initial documents from peer-reviewed mathematics and science journals and identified 16 studies that met their criteria. Empirical studies included in their meta-analysis had to be focused on K-12 public education settings in which teachers’ professional development was linked to student achievement. Only 4 of the 16 studies reviewed by Blank and de la Alas (2009) focused on science teachers’ professional development illustrating the limited body of research on effective science teacher’s professional development.

The Blank and de la Alas (2009) research highlights the importance of the current study because their goal was to give guidance to education leaders on the best strategies for effective professional development. Their two research questions were,

1. What are the effects of content-focused professional development for math and science teachers on improving student achievement as demonstrated across a range of studies?

2. What characteristics of professional development programs (e.g., content focus, duration, coherence, active learning, and collective participation of teachers) explain the degree of effectiveness, and are the findings consistent with prior research on effective professional development (e.g., content focus, duration, coherence, active learning, and collective participation of teachers)? (p. 5)

The use of the key words within both of their research questions – content focus, duration, coherence, active learning, and collective participation of teachers – indicates
that these words have specific connections to the field of professional development research. These words are consistent with words used to describe effective professional development in the other studies included in this section. These words will also aid in the analysis of the data in this study because the words can help discern the supervisors’ understandings of effective professional development.

The following three studies in this section are included because they are broad-based studies that do not focus solely on a singular professional development event. Interestingly, the three studies also have similarities to Blank and de la Alas (2009) in the words that they utilize when they describe effective professional development.

Banilower et al. (2007) posited that effective professional development had to be content-based, situated in practice, and sustained over time. In comparison, Garet, Porter, Desimone, Birman, and Yoon (2001) found the essential effective professional development core features to be content knowledge, active learning, and coherence with other learning activities. Finally, Ingvarson, Meiers, and Beavis (2005) found that effective professional development had a significant impact when it included a content focus, contained active learning, and had a component of follow-up including effective partnerships.

Banilower et al. (2007) added empirical data to understandings of effective science teachers’ professional development by analyzing 25,016 K-8 science teacher surveys from 42 local systemic change projects over the span of seven years. The focus of the study was to measure the impact of teachers’ professional development with an emphasis on preparing teachers to implement instructional materials. Although the researchers’ comprehensive study provided solid data, it was limited by its solitary focus
on teacher perception of multiple professional development programs. This is not a criticism of the Banilower et al. (2007) study as Borko (2004) identified that this type of study – one that is designed to learn about professional development from multiple professional development programs from multiple sites – is desperately needed, scarce, and part of the large puzzle. Rather, the point here is that the researchers missed an opportunity to better understand the impact of the teachers’ professional development by not including qualitative interview data from district-level science supervisors, which could have complemented the teachers’ self-reported data.

Garet et al. (2001) undertook empirical research that contributed significantly to understandings of teachers’ professional development. The focus of their study was to measure the impact of professional development on teachers who participated in a variety of professional learning activities that were funded by the Eisenhower grants. The study, similar to the Banilower et al. (2007) study, did not focus on one specific professional development program. Thus, Garet et al. (2001) and Banilower et al. (2007) represent studies that were broader in nature.

Further, the Garet et al. (2001) study was important because it provided core features of professional development activities. Garet et al. (2001) found that the core features of effective mathematics and science teachers’ professional development were that they contained the focus of content knowledge, provided opportunities for active learning, and had coherence with other learning activities. As with Banilower et al. (2007), the Garet et al. (2001) research was limited by the focus on teacher’s self-reported changes through a survey. The Garet et al. (2001) study added to the understandings of science teachers’ professional development but still examined
professional development from a limited perspective. Adding the qualitative interview data from district-level science supervisors could have helped to verify the understandings gained from the survey data.

Ingvarson et al. (2005) developed the *Quality of Professional Learning Index* (QPLI) tool, which included features of professional development focused on content, active learning, feedback, collaborative examination of student work, and a follow up. The QPLI tool was developed from a quantitative study that analyzed teacher surveys from 3,250 teachers in over 80 different professional development activities associated with four main programs. By including data from several different professional development activities, the Ingvarson et al. (2005) study was similar to the Banilower et al. (2007) and Garet et al. (2001) studies in being open to learning about professional development on a broader level rather than focusing narrowly on a specific activity. The focus of the Ingvarson et al. (2005) study was to measure the impact of teachers’ professional development activities associated with the Quality Teacher Programme in Australia. Although Ingvarson et al. (2005) met their research goals and added to understandings of professional development, the study was another example of research that was limited by its focus on self-reported survey data. Though such survey data are important and meet a focused research goal, interview data could add insights to the findings or and provide corroboration (Creswell, 1998).

The four studies reviewed in this section so far are examples of research that met outlined goals of measuring the impact of teachers’ professional development. They also illustrate the role that qualitative interview data could play if included in the methodological design. Another interesting observation from these studies is the
common words used to describe effective science teachers’ professional development including content, duration, coherence, active learning, and collective participation. These words remain consistent with what was outlined by the National Staff Development Council (NSDC, 2001) and the National Science Education Standards (NRC, 1996). The consistency suggests that the studies presented not only had important broader perspectives included in their research methods but also were well connected to the field.

The Greensfeld and Elkad-Lehman (2007) was an example of a qualitative study loosely related to the K-12 science teachers’ professional development field because they examined perspectives of college-level, science educators. However, Greensfeld and Elkad-Lehman (2007) provided an example of effectively utilizing qualitative research design methods to meet their research goals by conducting semi-structured, in-depth interviews with the participants. The inclusion of the semi-structured, in-depth interviews enabled the researchers to learn about the participants’ perspectives in a way different from only reviewing survey data. The Greensfeld and Elkad-Lehman (2007) study is also important because the researchers held a broad understanding of professional development as a process more than an event. They regarded professional development “as the whole of the processes and the outcome of continuous experiential learning, during the teacher’s career, by the teacher himself/herself or by colleagues, in the context of instruction” (p. 1220). This broad understanding of professional development is important because with this understanding, Greensfeld and Elkad-Lehman (2007) purposefully chose case study and employed semi-structured, in-depth interviews to learn about the participants’ perceptions.
Science Professional Development Studies Focused on Specific Programs

As mentioned earlier, several of the existing studies regarding effective professional development focus narrowly on specific curricular implementation efforts (Lord, 1994). To present more completely what is meant by relevant studies of specific programs, three studies are examined in this section of this chapter. Two studies are quantitative and revolve around the implementation of the same program and are examples of studies that rely upon teachers’ self-reported survey data. The final study in this section is an example of a narrowly focused study that met its research goals by utilizing some qualitative methods.

The purpose of the Penuel, Fishman, Yamaguchi, and Gallagher (2007) study was to measure teachers’ perceptions of the professional development associated with the implementation of the Global Learning and Observations to Benefit the Environment (GLOBE) program in different districts across the nation. Hierarchical linear modeling was used to analyze the surveys from 454 teachers that participated in the GLOBE project. Penuel et al. (2007) built upon other studies in methodologically important ways. The survey used by Penuel et al. (2007) contained items from the Garet et al. (2001) study reviewed earlier in this chapter, and Penuel et al. (2007) added survey data from partners so that teachers’ self-reported survey data was not the sole source of data. This study is also significant because it includes data from multiple sites across the nation.

Penuel, Fishman, Gallagher, Korbak, and Lopez-Prado (2009) provided a second study related to the implementation of the GLOBE program, and the focus was to measure teacher and program goal alignment and the extent of implementation of the GLOBE program in 51 schools across Alabama. The researchers administered a
questionnaire to 255 teachers to measure their perceptions. The Penuel et al. (2009) study is important because it builds upon Penuel et al. (2007) by changing the scope of the research. Penuel et al. (2007) included data from districts across the nation, while Penuel et al. (2009) was a statewide study. Both levels of breadth are important; however, the Penuel et al. (2009) study was limited to teacher self-reported survey data.

Penuel et al. (2007) and Penuel et al. (2009) revealed that breadth can be thought of in two ways regarding professional development studies. One way to examine how broad a study is would be to examine the context and how open the study was to learning about professional development at multiple levels (i.e., national, state, or local). A second way to understand how broad a study is would be the degree to which the study was open to learning about professional development experiences from multiple initiatives. For example, the Penuel et al. (2007) and Penuel et al. (2009) studies examined the same initiative at both national and statewide perspectives, which represent a departure from the breadth of studies represented in the last section (Banilower et al., 2007; Garet et al., 2001; Ingvarson et al., 2005) where the studies were open to learning about professional development associated with several different programs. Thus future studies should consider collecting data on effective science teachers’ professional development from both multiple professional development efforts and from multiple sites. The next chapter will show that the researcher in this study was interested in learning about science supervisors’ understandings of professional development from a broad perspective in both ways – from a national perspective and regarding multiple and varied professional development experiences.
The Venville and Dawson (2010) study was another example of science teacher professional development research that was focused narrowly on learning about the implementation of a specific program – classroom-based argumentation as a teaching strategy. The Venville and Dawson (2010) study is included in the review because the study effectively utilized qualitative methods to meet research goals and better understand professional development. The teacher participants in the Venville and Dawson (2010) study received professional development on the instructional strategy of classroom-based argumentation skills. Venville and Dawson (2010) measured the difference of high school students’ achievement based on the implementation of the professional development experience by examining student achievement scores and survey data. Venville and Dawson (2010) showed the important role that qualitative methods can have in science professional development research by utilizing case study methods of coding the open responses included in the survey data. In doing so, the researchers determined the level at which the science concept (genetics) was understood and the level to which the students utilized classroom-based argumentation (the learning goal of the teachers’ professional development experience). Thus, achieving two levels of understanding perhaps not possible with other research approaches.

Studies with important methodological designs from mathematics and English. In order to better understand science teachers’ professional development, it is appropriate to examine research from other curricular areas for two reasons. First, there was not a wealth of research focused only on effective science teachers’ professional development (Hewson, 2007; Lord, 1994). Second, science education research should borrow effective practices from other curricular areas because researchers from other
curricular areas have designed studies that share similarities with the research design methods needed in science.

For example, Wixson and Yochum (2004) declared that research regarding effective professional development for English teachers must take into account the environmental factor [context], which included classroom, school, district, state, and national levels. Dutro, Fisk, Koch, Roop and Wixson (2002) provided an exemplar of a professional development study that accounted for these environmental factors in the English field because the researchers interviewed district-level administrators to better understand the professional development activities related to the federally funded Michigan English Language Arts Framework (MELAF) project. Additionally, the Dutro et al. (2002) study was an exemplar because data was collected from multiple school districts, and their case study methods included collecting and analyzing documents in conjunction with conducting interviews. Even though the Dutro et al. (2002) study was limited to learning only about professional development associated with one program, the researchers were open to learning about the effects of the professional development in multiple school districts, thus achieving one level of breadth. Including the document review in the study is also important because they had the opportunity to juxtapose that data with the interview data during analysis, which gets closer to triangulation of data (Creswell, 1998). The Dutro et al. (2002) study is interesting because of the finding that district-level leadership was among the factors that influenced whether or not the statewide reform initiative caused change. Dutro et al. (2002) is another example of a study that put the district-level personnel into one category that aggregated data from superintendents, assistant superintendents, and lead teachers.
The Franke, Carpenter, Levi, and Fennema (2001) study from the field of mathematics also utilized important methodological methods as they focused on understanding the effectiveness of professional development activities related to the implementation of the Cognitively Guided Inquiry (CGI) program. The Franke et al. (2001) study was qualitative and longitudinal in nature. The study examined the changes in elementary mathematics teaching. From a methodological perspective, the strength of the study was that the researchers conducted observations and interviews to better understand the effectiveness of the professional development related to the CGI program, which verified the researchers’ data and led to more complete understandings of the professional development related to the CGI program. For example, Franke et al. (2001) were able to not only determine if the learning from the CGI professional development activities were present four years after the intervention, but they were also able to determine to what level change was implemented based on their analyses of the coded data from both the interviews and from the observations. Employing the interview and observation methods allowed Franke et al. (2001) to reach a similar depth of understanding that Venville and Dawson (2010) were able reach.

The five studies presented in the last two sections include two quantitative studies and three qualitative studies. Each study focused on a specific program or the implementation of a specific curricular implementation effort related to professional development. Three of the studies focused on efforts within the science field, while the last two studies provided learning opportunities from the fields of English and mathematics. The research included in these last two sections support two needs for research in the field of effective science teachers’ professional development. First, future
studies on the effectiveness of science teachers’ professional development can utilize more than self-reported teacher survey data and could include informants beyond science teachers. Second, future studies should also employ qualitative case study designs within multiple sites that include in-depth, semi-structured interviews, observations, and document review data to lead to more complete understandings of science teachers’ professional development.

**Summation**

The history and progression of science education in American public education has been influenced by several stakeholders and by specific events (Abell, 2007; Atkin & Black, 2007; Tyack, 1974). As interest in science education grew, the chief vehicle for impacting change in science education became professional development (Perry, 2004), and science teachers’ professional development has been guided by two sets of complementary standards (NRC, 1996; NSDC, 2001) which remain important today (Blank & de la Alas, 2009). District-level science supervisors are among a group of key individuals to influence education reform and the success of professional development activities within school districts and deserve to be studied (Spillane, 2000).

Studying the perceptions of district-level science supervisors will be difficult as their experiences and professional development itself each hold individual complexities (Hewson, 2007). These complexities necessitate initial studies with fundamental research questions and methods that include in-depth, semi-structured interviews and document review (Dutro et al., 2002; Franke et al., 2001; Greensfeld & Elkad-Lehman, 2007; Venville & Dawson, 2010). Further, initial research designs should include methods that are open to learning about science teachers’ professional development situated within
multiple school districts (Banilower et al., 2007; Garet et al., 2001; Ingvarson et al., 2005) and methods that are open to learning from the district-level science supervisors’ continuous experiences (Greensfeld & Elkad-Lehman 2007). The next chapter will explore how the key findings regarding design issues are handled in this dissertation.
CHAPTER 3

Methodology

Introduction

Qualitative research. The central goal of this study is to understand district-level science supervisors’ experiences and perspectives on science teachers’ professional development. Qualitative research is better able to assess and understand human experiences and perspectives (Bogdan & Biklen, 2003; Merriam, 1998) so it is the overarching methodology for this research. Bogden and Biklen (2003) also provided guidance for how to assess the merits of a qualitative research study through the rationale that “the [qualitative] researcher’s primary goal is to add to knowledge, not to pass judgment on a setting. The worth of a study is the degree to which it generates theory, description, or understanding” (p. 33). This study’s worth should therefore be judged on how well it adds the supervisors’ perspectives to understandings of effective science teachers’ professional development.

Qualitative research can utilize five traditional approaches: biography, phenomenology, grounded theory, ethnography, and case study (Creswell, 1998). The approach utilized in this work is case study as it provides for an in-depth understanding of the situation and its contextual meaning for those involved. This can influence policy, practice, and future research (Merriam, 1998). Merriam (1998) suggested that case study is appropriate when “discovery” is the goal rather than confirmation. Since the goal of this study is to add the district-level science supervisors’ voice to the literature on effective science teachers’ professional development, this form of qualitative research is appropriate for this study.
As previously mentioned, the phenomenon – the understandings of the district-level science supervisors regarding teachers’ professional development – includes multiple complexities (Hewson, 2007; Spillane, 2000). In addition to the complexity of understanding professional development and the complexity of the understandings of the district-level science supervisors, the participating science supervisors presented a continuum of degrees of involvement in professional development activities ranging from merely watching to being directly involved in the planning and facilitation of specific professional development activities. Because of these complexities, this study is limited to fundamental research questions and utilizes case study.

**Case study design.** This study employs a multiple-case study design from six urban public school districts with district-level science supervisors as key informants from six states. Stake (2005) provided theoretical guidance for this decision because “When there is even less interest in one particular case, a number of cases may be studied jointly in order to investigate a phenomenon, population, or general condition” (p. 445), which was consistent with the practical approach to understand professional development utilized by some current researchers as defined in Chapter 2. The goal of this study is to explore district-level supervisors’ perspectives of science teachers’ professional development. Therefore, it is the collection of the supervisors’ experiences and understandings of professional development that are the focus of this research, not necessarily their individual understandings of a specific professional development experience. The goal is to glean thematic insights into the role of these individuals who sit at a pivotal node in a network of players fostering professional development.
The Role of the Researcher

The researcher in this study had many different roles as he was responsible for developing the design of the study, conducting data collection, and analyzing the data. He was also an active learner with direct involvement on effecting processes that contribute to effective professional development because of his concurrent position as the science supervisor for an urban school district. This allowed him to connect quickly with the participants to establish rapport and his insights into the process allowed for deeper probing of the study participants’ views. However, his role and experience also had the potential to unintentionally influence the direction of the dialog with the participants. This issue of potential bias has been raised previously, and to avoid subjective bias the researcher strictly followed the interview protocol (see Appendix) and did not include data from his district.

Case Study Procedures

Study approval. Prior to this study, the researcher conducted a pilot study regarding effective professional development for science teachers from educational service unit providers’ perspectives. Approval for conducting the pilot study was obtained from the Institutional Review Board (IRB) at the University of Nebraska-Lincoln. After completion of the pilot study and prior to beginning this study, the IRB approval was amended with a change of protocol form. The main differences between the two studies were that this study had an increased number of participants, and sought to understand professional development from district-level science supervisors’ perspectives. In contrast, the pilot study included participants who were local area
science support individuals, such as educational service unit professional development providers.

The pilot study was also limited to professional development experiences that were funded by the National Science Foundation (NSF). This was limiting because both pilot study participants asked if they could share more experiences that were not funded by the NSF and because they were distracted from responding to the interview questions by trying to recall the funding source for a professional development experience.

Another difference was that this study sought understandings for urban school districts with more than 30,000 students. District size was not a factor in the pilot study because it was a study with a sample of convenience. The current study focused on urban districts of more than 30,000 students because smaller districts are often not structured to include a district-level science supervisor and approximately 30% of the nation’s youth are educated in urban schools (Hoffman, 2007).

**Access and permissions.** The initial research proposal indicated that the researcher would seek additional institutional or IRB approval if any of the participants’ sites required their own institutional IRB or permissions before continuing. None of the sites included in this study required additional institutional or IRB approval.

The researcher used the contacts that he had made at national and area conferences including the American Education Research Association, the National Science Teachers Association (NSTA), and the Magnet Schools of America. Additionally, NSTA hosted an Urban Science Education Leaders (USEL) conference. Through networking at the USEL conference, the researcher was able to connect with potential participants from several urban districts across the United States. Finally, the
last participant was found by cold-calling. The researcher went through the informed consent process with subjects prior to conducting the interviews.

**Sampling.** This study employs purposeful sampling in conjunction with convenience. Merriam (1998) posited “Purposeful sampling is based on the assumption that the investigator wants to discover, understand, and gain insight and therefore must select a sample from which the most can be learned” (p. 61). The researcher wanted to discover science supervisors’ perspectives of effective science teachers’ professional development based on their experiences to add to current understandings of professional development. As such, he identified potential participants as those who were open to sharing their experiences and understandings at professional meetings and conferences when possible. As discussed in Chapter 1, this can limit the findings of the study.

**Participant selection.** The selection criteria for this study included two pools of participants, with district-level science supervisors as key informants, which were formed from six urban public school systems: one pool of three districts with over 100,000 students, and the other pool of three districts with 30,000 to 100,000 students. The contextual and demographic data is presented in Chapter 4, and Figure 3.1 below shows the six districts in two clusters. The two overlapping circles represent the two clusters, and each box within the two circles represents an individual case. The names in the six boxes are the pseudonyms for the six female key informants from each district. The image is organized to represent multiple levels of analyses and findings, thus leaving room to learn from the individual case, the two clusters, and across the two clusters. Furthermore, the boxes in Figure 3.1 representing the individual cases are not overlapping but linked to the other two individual cases within each cluster circle.
This represents the two layers of analysis, one at the individual case level and the other at the cluster level. The cluster circles are shown as overlapping circles to represent another layer of analysis, the cross cluster analysis or the overlapping portion of the two circles.

Although reliable generalizations may not be able to be made from this type of research (Verschuren, 2003), the phenomenon of effective science teachers’ professional development was explored in the context of individual cases from six different states in an effort to maximize the variation of the sample. This better allows for sampling the range of participants. The researcher unsuccessfully attempted to utilize snowballing (Hatch, 2002; Merriam, 1998) as a technique to find additional participants. In this technique an informant from one site identifies potential participants from other sites, and the researcher follows up on the leads from study participants. The researcher then cold-called several districts to find a willing participant in a third district with more than 100,000 students.
**Data collection.** Multiple sources of information were utilized to gain an overall picture of the individuals’ perspectives. Merriam (1998) determined that “Data are collected through interviews, observations, or document analysis” (p. 11). The qualitative data in this study was recorded in field notes, protocols, and audio recordings, which were transcribed for review and analysis. Qualitative data can be organized into four main types: interviews, observations, documents, and audio-visual materials (Creswell, 1998). By the second edition of his book about qualitative inquiry, Creswell (2007) began to encourage researchers to include new and creative data sources. Markic, Eilks, and Valanides (2008) developed and utilized drawings as a research tool for a case study about science teaching. The Markic et al. (2008) tool was based on earlier work by Thomas, Pedersen, and Finson (2001) where the researchers examined mental models and teacher beliefs. The analysis of the drawings varied between the two examples cited here; Thomas et al. (2001) analyzed the drawings with specific questions and assigned a score to each drawing, whereas Markic et al. (2008) openly coded the drawings. With the charge from Creswell (2007) and the recent examples of research utilizing participant drawings (Markic et al., 2008; Thomas et al., 2001), the researcher in this study collected participant drawings of effective and ineffective professional development as data for this dissertation and then openly coded them for analysis.

The three types of data consistently collected were interviews, participant drawings, and artifacts used in document review. The primary data are the participant interviews. The participants received the interview protocol (see Appendix) in advance of the interview, and the interviews took place in the science supervisors’ offices. The interviews lasted approximately one hour, and they were digitally audio recorded and
then transcribed. The transcriptions were coded and used to create individual case summaries.

In addition to the interviews, drawings, and artifact collection, the researcher was also open to participants’ invitations to conduct observations, which were recorded in the researcher’s journal. Some of the observations were conducted at meetings, while others were direct observations of professional development offerings that the district-level science supervisor felt embodied an exemplary model of professional development. The researcher often met with the team charged with providing the professional development for science teachers. This group included professional development facilitators, science lead teachers, and other partners. Table 3.1 shows the dates of the interviews, the types of observations the researcher was invited to, and participant drawing information. Since the observations varied greatly and the interview was the focal data for this study, the observation data was utilized to help the researcher make sense of the interview data. This is consistent with the methodological practice to have one data set take the dominant position and utilize the other data sets as support (Creswell, 1998).

During the interviews, the district-level science supervisors were asked to draw pictures of effective and ineffective professional development. Table 3.1 identifies who was involved with the interviews, observations, and drawings. At the conclusion of the interviews, the supervisors were asked to gather artifacts from professional development experiences. Artifacts included professional development handouts, agendas, books, presentation slides, and other documents that the supervisors selected.
Table 3.1

*Interviews, Observations, and Drawings by Cluster*

<table>
<thead>
<tr>
<th></th>
<th>Small Urban Districts</th>
<th>Large Urban Districts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Onsite interviews</strong></td>
<td>MSD1, Loren, 11/30/07</td>
<td>ESD, Ellen, 12/18/07</td>
</tr>
<tr>
<td></td>
<td>PNSD, Bonnie, 12/17/07</td>
<td>CSD, Sandra, 12/20/07</td>
</tr>
<tr>
<td></td>
<td>PNSD, Michelle, 12/17/07</td>
<td>SSD, Susan, 7/17/08</td>
</tr>
<tr>
<td></td>
<td>MSD2, Clara, 1/30/08</td>
<td></td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>PNSD, University-led professional development offering</td>
<td>CSD, Science math and literacy meeting</td>
</tr>
<tr>
<td></td>
<td>MSD1, Supervisor meeting</td>
<td>CSD, Science team meeting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CSD, Holiday party</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SSD, Science integration team meeting</td>
</tr>
<tr>
<td><strong>Drawings</strong></td>
<td>MSD1, Loren, 11/30/07</td>
<td>ESD, Ellen, 12/18/07</td>
</tr>
<tr>
<td></td>
<td>MSD2, Clara, 1/30/08</td>
<td>CSD, Sandra, 12/20/07</td>
</tr>
<tr>
<td></td>
<td>PNSD, Michelle, 12/17/07</td>
<td>SSD, Susan, 7/17/08</td>
</tr>
</tbody>
</table>

Table 3.2 is organized to show how the researcher used the artifacts to construct understandings of the participants, the district context, and the participants’ perceptions of professional development. The two clusters of district sizes were also used to organize Table 3.2 with the six individual cases under either the smaller or larger urban district headings. As can be seen in Table 3.2, not all participants shared equal amounts of artifacts. For example, Clara from Midwest School District 2 did not produce any documents to assist in developing an understanding of her as a participant.

**Utilizing the data.** Due to the distance separating the researcher from each of the participants, air travel was used to conduct the face-to-face interviews for all but two participants who were within driving distance from the researcher. The face-to-face interviews were conducted between November 20, 2006, and February 1, 2008.
Table 3.2

*The Type of Participant Artifacts Collected by Cluster*

<table>
<thead>
<tr>
<th></th>
<th>Smaller Urban Districts</th>
<th>Larger Urban Districts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MSD1</td>
<td>PNSD</td>
</tr>
<tr>
<td>Understand the participant</td>
<td>Loren’s calendar &amp; job description</td>
<td>Chapter of a book by Bonnie</td>
</tr>
<tr>
<td>Understand the district context</td>
<td>District’s map, test results, science leaders’ survey, state professional development model, science budget, course offerings guide</td>
<td>High school core concepts, district test results, scoring rubrics, professional teachers of science document</td>
</tr>
<tr>
<td>Understand the participant’s perceptions of professional development</td>
<td>Professional development activity proposal forms &amp; offerings, elementary professional development plan and worksheet</td>
<td>Professional development applications &amp; agendas, inquiry document, report on the impact of reform related to state tests</td>
</tr>
</tbody>
</table>
Seidman (2006) suggested a “Three interview series: Focused life history, details of the experience, reflection on the meaning” (p. 117). The researcher funded this study:\footnote{The researcher applied for and received a $1,500 Science Education Fellowship from the University of Nebraska Lincoln ex post facto to offset a portion of the travel costs.}; therefore, limited resources meant that he could not conduct three face-to-face interviews. However, the researcher did try to adhere to Seidman’s (2006) suggestion by calling the participants to answer follow-up questions from the onsite interviews and by utilizing the observation data when possible. The participant interviews had two main goals. The first goal was to construct an understanding of the individual, their job, how they came to be in that position, and the context of the district itself. The second goal was to construct an understanding of the supervisors’ knowledge and perceptions of effective professional development for science teachers.

A digital voice recorder was used to record the interviews, and the digital, audio files were sent to a company for verbatim transcription. The digital, audio files were also imported into iTunes, which was used to play the files back to check for verbatim transcription. It was necessary to save the document transcripts as “txt” files before they were imported as a text source in HyperRESEARCH, which was the computer software program used in data analysis.

The second consistent data set was the participant drawings of effective and ineffective science teachers’ professional development. During the interview, each participant drew a picture of what they believed represented effective and ineffective professional development for science teachers. The participants each were supplied with two, normal-sized sheets of white typing paper and a pencil or pen. It was sometimes necessary to photocopy the participant drawings to darken the lines prior to scanning.
because the drawings were not always dark enough to be picked up by a scanner. Once the participant drawings were scanned, they were saved as “jpeg” files. They were then imported into HyperRESEARCH for coding. It was also necessary to resize the images for computer analysis. To reduce the actual size of each drawing, the researcher used GraphicConverter to scale each picture down, first by 50%, then again by 30%, which allowed for a workable size for the screen and for coding within HyperRESEARCH.

Sandra from the Central School District choose not to use the supplied paper and instead drew a picture of effective professional development on the white board in her office. The researcher took a digital photo of the image on the white board and analyzed the photo by open coding it in the same manner as the other scanned images.

The final consistent data set included the artifacts that the participants gathered. The participants generally produced the documents for review during the site visit and occasionally sent the artifacts after the interviews were conducted. The artifacts included journal articles generated from one of the science teachers’ professional development activities, reports of a professional development workshops, letters, fliers, and brochures developed to solicit teacher and building participation in science teachers’ professional development activities. These artifacts, when possible, were also imported into HyperRESEARCH for coding and analysis. To load them into HyperRESEARCH, the artifacts were either saved as text files or scanned and converted into “jpeg” files using GraphicConverter. This process readied the files for the computer-assisted analysis. In some instances, the artifacts were coded by hand. In each case, the electronic data files were stored on the researcher’s computer, and the hard copies were kept in a locked file cabinet.
Data analysis and verification strategies. In Creswell’s (1998) methodological framework, “the investigator may ‘layer the analysis,’ presenting numerous themes initially, followed by more abstract categories later” (p. 77). In this study, the researcher presents numerous themes within each specific case and then adds more broad categories within and across clusters of cases in the analysis. This organization of presentation is important to this study because there are key learning points and themes that were reiterated among all of the individual cases, and there are equally important learning points found only in individual cases.

The three consistent data points (interviews, participant drawings, and artifacts) are used as a verification strategy that Stake (1995) called “Data source triangulation” (p. 113). The three data sources are utilized as confirming or disconfirming evidence for understandings and emerging themes. For example, the interviews are sometimes used to help make sense of the participant drawings and vice versa. Sometimes the triangulation revealed a mismatch of what the participant reported in the interview to what the document review held, which served as a basis for follow-up questions to the participants. Table 3.3 shows how the three consistent data points are used to construct meaning.

To present the data, the researcher first presents the contextual, demographic data, and emerging themes for each individual case. He then presents the emerging themes from the aggregates of the three-district clusters by size, and he finally presents the emerging themes from all six individual cases (Creswell, 1998; Stake, 1995). As mentioned earlier, the two clusters include one with three districts with more than
Table 3.3

**Uses of Data Collected**

<table>
<thead>
<tr>
<th>Uses of Data Collected</th>
<th>Interviews</th>
<th>Participant Drawings</th>
<th>Artifacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervisors’ background</td>
<td>•</td>
<td></td>
<td>•</td>
</tr>
<tr>
<td>Supervisors’ experiences with professional development</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Supervisors’ perceptions of professional development</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Supervisors’ ability to negotiate barriers to professional development</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
</tbody>
</table>

100,000 and the other cluster contains three districts with between 30,000 and 100,000 students.

Hatch (2002) provided eight steps for interpretive analysis:

1) Read the data for a sense of the whole.
2) Review the impressions previously recorded in journals and/or bracketed in protocols and record these memos.
3) Read the data, identify impressions, and record impressions in memos.
4) Study the memos for salient interpretations.
5) Reread data, coding places where interpretations are supported or challenged.
6) Write a draft summary.
7) Review interpretations with participants.
8) Write a revised summary and identify excerpts that support interpretations.

To aid in analysis, the researcher organized Hatch’s (2002) interpretive analysis into three phases. The first phase included reading the data as a whole, reviewing his field journal and recording memos, identifying impressions, and recording impressions in his field journal. The second phase included studying the recorded memos, rereading the data to code interpretations, and writing a draft summary. The researcher added listening to the audio files of the interviews to the second phase in an effort to stay connected to
the data. The final phase included reviewing the summaries with the participants and revising the summaries. The researcher utilized computer software whenever possible to assist with these processes.

HyperRESEARCH is the computer program used in this study to assist in the analysis of the transcriptions of the participant interviews, the participant drawings, and whenever possible, the artifacts. The researcher coded the electronic files within the computer program and did not use automated coding. The computer program was used to generate reports of data that were lists of commonly coded material, in which, each data point on the report was hyperlinked back to the original data source in context. The ability to maneuver quickly back to the coded text in original context was important during coding and when the emerging themes were developed.

Throughout the analysis, the researcher also completed what Stake (1995) called “Document review” with the artifacts (p. 68). Accordingly, the artifacts were coded by sorting them into categories. Then the categories were compared to the themes from the participant drawings and interviews. Hatch’s (2002) seventh step was to “Review interpretations with participants” (p. 181). Stake (1995) heralded this process as “Not very satisfying but entirely necessary” (p. 116). This process simply involved asking the participant to review the findings of the study. This process was completed with follow-up phone calls. Chapter 4 will report the key learning points and emerging themes from each individual case, from both clusters of individual cases, and from across all six individual cases.
Research Questions

The central research question for this study was: What can district-level science supervisors add to understandings of effective science teachers’ professional development? The sub-questions included:

1. How do district-level science supervisors perceive and describe their experiences with teachers’ professional development?

2. What value do district-level science supervisors ascribe to their experiences with professional development for science teachers?
   a. How do district-level science supervisors define effective professional development?
   b. How do district-level science supervisors define ineffective professional development?

3. What can district-level science supervisors tell us about the origins, intended goals, or visions for science teachers’ professional development versus the actual outcomes of science teachers’ professional development?
   a. In what ways can the barriers to effective professional development for teachers be overcome?
CHAPTER 4
Presentation of the Data & Initial Analysis

Introduction

This chapter provides a description of the six individual cases, presents the data, identifies the emerging themes from the individual cases, identifies the emerging themes from the two clusters of cases, and identifies the cross-case themes. The key informants for this multiple-case study are the six district-level science supervisors. Ten additional support staff such as lead teachers, science coaches, university partners, and local educational support agency personnel also serve as informants for this study. As previously mentioned, the participants are from two main clusters of districts with three district-level science supervisors from large urban districts with more than 100,000 students, and three participants from smaller urban districts with between 30,000 and 100,000 students.

The six participants are similar in that they all work in public school systems. They are all also responsible for maintaining only the science curriculum in their districts. They are not responsible for multiple discipline areas, such as mathematics and science. All of the participants are former teachers, and five of the six have previously been science teachers.

In the case where the participant was not a former science teacher, Pacific Northwest School District (PNSD), an in-depth interview was also conducted with the district-level science lead teacher, Michelle, who was a former science teacher. Due to her science-teaching background, and the fact that her district-level science supervisor relied heavily on her for professional development, Michelle’s interview and drawings
also serve as key data points for PNSD. The participants’ districts each represent either
the largest or second largest district in their respective state by number of enrolled
students, and the cases are located in six different states. All demographic and
assessment data for the context of each site was found on state or district websites. As
such, citations are not included in an effort to mask the districts’ and participants’
identities.

Large Urban Districts

The large urban districts all have over 100,000 students, and each was selected
because of convenience and size. The researcher met two informants at an Urban
Science Education Leadership conference held in conjunction with a 2007 National
Science Teachers Association area conference in Denver. The researcher identified
several districts meeting the size of over 100,000 students then cold called district-level
science supervisors to find the third case.

Eastern School District. The first large district is located in Eastern United
States. As reported on the state’s education report card, Eastern School District (ESD)
has over 130,000 students with a graduation rate of approximately 66%. ESD students
who took the SAT scored 1006 on average, which, was very close to the state average of
1007. ESD requires students to earn credit for three years of science in high school.
ESD has 17 high schools, 29 middle schools, and over 80 elementary schools. Ninety-
one percent of the high school teachers are considered highly qualified by holding
appropriate field endorsements, and 26% hold advanced degrees. Approximately 43% of
the teachers have more than ten years of teaching experience; 30% have between four and
ten years of teaching experience, and about 27% have zero to three years of teaching experience.

Ellen. Ellen has a number of years of experience in teaching and district-level work. “I taught biology and chemistry for 21 years, 15 in [a Northeastern state] and five and-a-half in [another Eastern state]” (Ellen, personal communication, December 18, 2007).” With those years of experience, Ellen is the participating district-level science supervisor who has the most classroom experience. Ellen is also the only science supervisor in this study to hold a Ph.D.:

I have a B.S. in Zoology, Masters in science teachings from Syracuse University, and then I finished my Ph.D. at [a university] in Australia. And once I finished my Ph.D. and looked at kind of a bigger picture of other things that weren't maybe attracting in the classroom, I started thinking that I would like to be at district level and teach teachers to teach the way I teach. That was ultimately what my goal was. (Ellen, personal communication, December 18, 2007)

Ellen quickly revealed that her ultimate goal was to get the teachers to teach as she taught.

Ellen also talked about the path that led to her becoming a district-level science supervisor:

The person who was here before me left in December before a textbook adoption started the next month because she'd gone through it, and she said never again, once she got through the textbook adoption. She took another job, and I was very excited about it because I think textbook adoption is where you are having those powers. [I was in] the 20th largest school district, and I was able to negotiate laptops and LCD projectors for the high school teachers and middle school teachers and kits for elementary. I thought like it was a great time to come in. So in this district, like elsewhere, we had kids from over 100 countries. I just felt like there was so much potential. There were so many things we weren't doing, and . . . it's like we all kind of believe we can change the world. (Ellen, personal communication, December 18, 2007)

Ellen certainly spoke with the energy it would take to implement change and revealed that she felt that she could change the world.
Ellen was really frustrated by teachers who would show up to professional development activities fully prepared to learn nothing. There were “PD Junkies” (Ellen, personal communication, December 18, 2007) that she could not understand. Ellen and her husband own several McDonald’s, and she made the point that a person could go to work at a fast-food restaurant making doughnuts and earn more money than some folks who went to every professional development offered. The teachers, in her opinion, were just going to the professional development because there was money attached to the event. She could not understand why these teachers would go to everything offered:

Because we have these other PD Junkies, which I don’t really understand, they come every day, even in the summer, to get paid $100. When it’s taxed at the stipend level, they get about $52, and it takes them six days to get the dollars. You know, they are just really desperate for the money, and they just come, sit and do nothing. (Ellen, personal communication, December 18, 2007)

Issues of pay came up in other individual cases, but in ESD, Ellen reported that the pay drew teachers to professional development offerings without the teachers’ perceiving that they would benefit.

Ellen believes that paying teachers money is important for professional development, but that effective professional development changed teacher’s perspectives, “And so I feel like really quality PD will do that [cause change], and we want to open lines of communication, and we will increase collaboration; it changes the teacher’s perspective” (Ellen, personal communication, December 18, 2007). She believes that the best way to cause change in teachers is through effective professional development:

I think if you talk to people across the country, anybody who understands anything about teaching and they would win the lottery, they put the money in professional development. We all know it's the most important thing. It's just [the question of] how do we deliver it effectively and efficiently. (Ellen, personal communication, December 18, 2007)
With this statement, Ellen expressed the importance of professional development, and she also touched on the importance of research in education to understand how to deliver professional development effectively and efficiently. Ellen explained more about the importance of research:

> It [research] needs to happen, and what we have done is look at the research. In fact, research is best practice. It is the backup we all want. I mean, we know what quality science teaching and learning looks like and feels like, but I just think it's time to be data-driven and research-based. (Ellen, personal communication, December 18, 2007)

Being data-driven is important for Ellen, and she explained how being data-driven played out in ESD:

> The superintendent put together a plan 2010 because when he came in and spent six months looking at it, he felt like we were all over the place, and we needed to have somebody to focus. Then he asked his directory team to kind of focus, and . . . it was easy. In science, it's inquiry K-12, and in math, it's algebra that goes K-12. So in the documents, we just have it that way so [when] somebody new comes in, a community member joins our service integration team like the one that you saw yesterday, or parents just want to see what we are doing; they can go and look and see what's the focus here. (Ellen, personal communication, December 18, 2007)

Ellen (personal communication, 2007) revealed that the superintendent provided guidance for professional development in ESD with the 2010 plan. Further, she identified that inquiry was the focus for science. The document review confirmed that inquiry was the focus for science in ESD as the *ESD Strategic Plan 2010* (Eastern School District, 2006) stated that the goal for science professional development was inquiry.

> Experiential learning, or teacher immersion in a content learning experience, is important for effective professional development (Ellen, personal communication, December 18, 2007). Ellen reported that “Another big goal of mine is to get more teachers involved in that kind of experiential learning in the summer. We have increased
the number of people who go on these kinds of trips” (Ellen, personal communication, December 18, 2007). It is essential for Ellen that her teachers go on trips in the summer where they can have a content immersion experience in science. This is so important to Ellen that she works to increase the number of teachers that can be involved in an immersion experience.

Ellen explained how she increased the number of teachers; “We have to kind of do that with one teacher at a time, and you build the relationship” (Ellen, personal communication, December 18, 2007). Ellen built the relationships with her teachers so that she could encourage them to take part in the immersion experiences. The fact that Ellen felt compelled to push teachers into the immersion learning experiences is evidence that she really believes that those types of experiences are important for effective science teachers’ professional development. She revealed more about pushing the teachers into immersion experiences:

It’s like the people you are trying to hire; you send them the personal invitation. Now you just can’t have a direct line to all 15,000 teachers, but you need to tell them to apply for this [and say], “You are the kind of person they are looking for.” Sometimes teachers just need somebody else to say, “You believe in me.” I need to go and push them out of the nest and then they will get others going. (Ellen, personal communication, December 18, 2007)

With this, Ellen revealed that a push is necessary along with providing the opportunity for the content immersion experiences to get teachers to involve themselves and others in professional learning.

Ellen further described an immersion experience and related it to effective professional development by saying, “When I think of professional development, I think even broader into like learning. And the most effective learning you ever have is when
you are fully immersed in it” (Ellen, personal communication, December 18, 2007).

Ellen gave an example of one of her immersion experiences:

I was out for a month in the Colorado Rockies and after we had been out for two-and-a-half to three weeks, they put us in new groups without an instructor and gave us a map and said you have three days to get to this place. So you now have every reason in the world to read your map accurately to envision your place, to know where the water is. The group that I was in, well, the one who was leading, [it was as if] he was smoking pot. Anyway, we ended up hiking all night because this idiot guide was lost. But I will always know how to read a topographic map because after that; I am like give me the map, get out of the way; we are not going to smoke pot all over this mountain. (Ellen, personal communication, December 18, 2007)

In Ellen’s point of view, she learned topographical map reading skills out of necessity and because of her immersion experience in the Rocky Mountains.

Ellen then related another experience immersion experience to education stating that “I know that's not exactly what teaching does, but I think about the things that I have learned as a teacher; they’re most effective when you are immersed and like the class I had in the Grand Canyon” (Ellen, personal communication, December 18, 2007). Again, she was providing evidence that she believes that content immersion experiences are necessary for teachers.

Ellen returned to the immersion idea several times during the interview and explained the experience as being a gift when she was allowed to write lessons during the content immersion experience:

We were there for two weeks, and we were writing curriculum and interdisciplinary curriculum for teachers. We were living at the ranger station. Every day we hiked a couple of hours. One day, we sat at the South Rim and we were not allowed to talk to anybody for an entire day. They played like Native American music; you were supposed to just sit around, reflect, write poetry, or whatever; it was like the nicest gift anyone's ever given me. You sit here for a day, enjoy the beauty of this place, soak it all in. We then started writing lessons that would help groups of kids come [and] have a similar kind of experience. (Ellen, personal communication, December 18, 2007)
Ellen enjoyed the ability to soak in the experience and then write related lessons. She summed up immersion experiences as being effective professional development which “is something that touches lots of different learning styles; I mean your whole body is immersed in this learning experience” (Ellen, personal communication, December 18, 2007). Ellen admitted that the immersion experiences are not easy to provide; however, she believes that they are essential to effective science teachers’ professional development.

Ellen also stressed that it is important to have the teachers become learners during the professional development experience and not so necessary to tell the teachers that you are attempting to change them:

So they are actually becoming the kid; they are being in that classroom. And as they are just coming on, we don't start out and say, “This is going to change your idea of how you teach.” We throw them out to deep and let them experience it and then we say, “Okay, tell us what you think now.” It's very constructivist and so by the time they are gone, they are all saying, “Oh well, I need to be doing this all the time,” and that the . . . teachers all are saying, “Every teacher needs to have this; why are you just saying it's for science?” I think it's that kind of experience [that is essential] because they are living and staying in touch with the people who they were with then, and they are asking for more. So that tells me that it is making a difference. (Ellen, personal communication, December 18, 2007)

With this comment, Ellen revealed that she believes that effective professional development would be constructivist in nature in that she wants teachers to have an experience and then help them make sense of their learning.

Ellen also believes that it is important to get teachers to ask questions about their learning in professional development akin to getting their students to ask appropriate questions during their learning:

There is a Nobel Prize winner who worked with me. . . . He won a Nobel Prize performing in physics. He said everyday when he went to school, he's in his 80s
[now], when he came home his mom didn't say, “What did you learn today?” She said: “Leon, what question did you ask today?” And, so I would kind of like to try to use that with the teachers. Think about that with your kids; how can you get them to ask more questions, how can you get them, I mean, it doesn't matter if it's analyzing a graph, analyzing a procedure, asking some question that you think is far out, just little kids kind of questions, but just get them to ask more questions. So through all the activities we do, we try to get the teachers to be very open-minded about a variety of ways for the kids to learn things. (Ellen, personal communication, December 18, 2007)

These words highlight the importance of meta-cognition to effective science teachers' professional development for Ellen. She wants the teachers to have opportunities to reflect on their learning, to ask questions about their teaching, ask questions about what they learned, and ask themselves questions about how they understood what they learned.

**Drawing out the difference between effective and ineffective professional development.** Figure 4.1 shows Ellen’s drawing, which yields several insights to her perception of effective professional development. To start with, the participants in both effective and ineffective professional development have smiles on their faces.

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**Figure 4.1.** Ellen’s drawing of effective and ineffective professional development.
The effective professional development drawing has the participants engaged with other participants and more active, which would make one believe that they should be the happy ones. The fact that the ineffective professional development participants are smiling could be related to the note Ellen made earlier in her interview regarding the PD Junkies who attend anything with dollars tied to it, which was the group that she could not understand.

Ellen also illustrated that effective professional development is different for different people. She has three main groups of people in her drawing regarding effective professional development, which is in stark contrast to the two individuals interacting with only their paper or book in their lap in the drawing of ineffective professional development. The ineffective professional development side yields no musical notes, no partnerships, no collaboration, nor any joint presentations.

The facilitators on both sides of Ellen’s drawing are similar. They are both standing, and the facilitator from the effective professional development side is shown giving instructions. A main difference between the two sides is the apparent activity level. The ineffective side shows the participants seated with no peer-to-peer interaction. In her interview, Ellen highlighted recruitment to effective professional development as another important aspect of peer-to-peer interaction. Her view was that “in a large district, the challenge becomes to develop more of those networks [peer-to-peer communication networks] because the best way to get somebody to come to PD is word of mouth” (Ellen, personal communication, December 18, 2007). Hence, there are two ways that the peer-to-peer interactions are important. One way is that the dialog is
important for learning during the professional development event. The other way that the peer-to-peer interaction is important is that Ellen utilized word-of-mouth to get more teachers to attend professional development offerings.

Ellen expressed frustration regarding one aspect of intended goals not coming to fruition. She lamented having paid for teachers to go to professional development offerings and then having them not show up; “Last summer we paid for 10 middle school teachers to go to a leadership thing; six showed up” (Ellen, personal communication, December 18, 2007). Ellen was caught in the quandary of not wanting the price for professional development to prevent teachers from being able to go and the reality that if her teachers did not pay anything for the experience, it was fairly easy for them to forgo attendance. This particular example was especially painful for Ellen in that she had prepaid for the teachers’ attendance.

Emerging themes within Ellen’s case. Ellen presented several interesting ideas. The following are emerging themes from the case: (a) Teach as I Taught. As far as teaching science is concerned, Ellen wants teachers to teach the way that she taught, and she believes that effective professional development should be set up to accomplish that, (b) Effective Professional Development Causes Change, (c) Effective Professional Development Requires Building Relationships, and (d) Effective Science Teachers’ Professional Development Must Include Immersion Experiences in Science.

Central School District. The second large district in this study is in the Central United States. Central School District (CSD) has over 300,000 students with a 55% graduation rate. The student body is 90% minority and 87% low income. Sixty percent of CSD students met all test requirements, which is below the 74% state average of
students meeting all test requirements. CSD requires students to earn credit for three years of science in high school. CSD is comprised of over 600 schools and has more than 100 high schools. In 2007, CSD teachers average 13.2 years of experience and a non-highly qualified teacher teaches 23.5% of classes.

*Sandra.* Sandra did not start out in science education, but she had wanted to. Instead, she “started out my career actually as a speech pathologist. I did speech pathology for several years for the district. I have always wanted to be a science teacher” (Sandra, personal communication, December 20, 2007). Sandra eventually fulfilled her desire to become a science teacher and won a major teaching award. “Eventually, I became a science teacher; I taught in a very challenging school for many years, and I won a national science teacher’s award” (Sandra, personal communication, December 20, 2007). Sandra held that once she won the award, she was promoted out of the classroom to help others by becoming “what we consider an area coach for math and science” (Sandra, personal communication, December 20, 2007). Becoming a coach for math and science was a step towards becoming the science supervisor for Sandra. Sandra described her position as a science coach as mostly administrative:

> With the rather large district that we have, we have always been grouped according to the number of schools in a particular area. I was primarily responsible for math and science in about 40 schools, and when I say responsible, I was really an administrator [who was] not really responsible for the teaching and learning going on, but [rather] for compliance and policy issues, from budget issues, those kinds of things. (Sandra, personal communication, December 20, 2007)

With this, Sandra revealed that she was more interested in teaching and learning and not as much interested in the administrative work. She disliked the administrative portions of her science coaching position so much that she left the job and CSD.
Eventually, Sandra became frustrated with the administrative work and looked for other ways to connect with science. She was “Becoming totally frustrated in doing that kind of work and not really digging deep into science, [so] I left the district, and I began working for [a] university” (Sandra, personal communication, December 20, 2007).

Sandra further described her position at the university and her reentry to CSD:

I was the liaison between the university and several large public school districts. So the university office of social policy had a number of national NSF grants, and my responsibility was to make sure that the school districts were in compliance with the grant regulations to formulate teams of teachers working on developing and implementing variety of group science curriculum, so that was my role as a liaison. After about six years of doing that, the science supervisor here at CSD retired. At that point, we were going through a major change like most school districts do every several years, and we had a new director, chief officer of math and science. He then asked me to do the science manager's work. I was very cautious because I had been there already, but he had a vision, and he had a plan that would be very feasible. (Sandra, personal communication, December 20, 2007)

Sandra was not all that happy working with the grants at the university, but she was wary about returning to CSD. Without her belief in the new director and his plan, Sandra would not have returned to CSD.

Sandra decided to assume the new role, even though the new role held some similarities to her past position, because she believed that this time would be different:

In addition to [the feasible plan], he had dollars, now. Chris, you and I both know how relevant having money is to implement anything. In the past, before the new director came in, our district math and science was supported solely by grants. There was no internal funding out of our central office budget for math and science. He made that change. He actually acquired money out of central office to do the work for math and science, which showed me that, yes there is some true evidence now that math and science are important to the district because dollars were allocated. (Sandra, personal communication, December 20, 2007)

Sandra’s reentry to CSD was important because of Sandra’s reasoning; in addition to the necessity of a solid and feasible plan, Sandra also believed that the money allocation to
science signified science and the supervisor role as important. As can be seen above, Sandra (personal communication, December 20, 2007) equated the allocation of district funds to science as a signal that science had prominence. Moreover, with the money allocation, she would be able to make real changes for science in CSD.

Sandra explained more about her new role at the district level:

So I was the science manager. I had a staff of five science facilitators that I supervised. In addition to that, there was also a co-supervisor for the area coaches, and our district again was divided into these areas [and] each area has a math-science coach. Again, they were almost basically the same as my role and that was administrative. (Sandra, personal communication, December 20, 2007)

In addition to Sandra and her team taking care of the necessary administrative tasks, she also began to build capacity for leadership in science. “One of the things that I did as science manager was try to convert their role from becoming administrators to really working with teachers and principals” (Sandra, personal communication, December 20, 2007). This was the important shift from administrative tasks to working with teachers and principals and the teaching and learning of science that is important for Sandra.

Sandra then described how she implemented the shift:

So I started developing professional development modules for them to use with their science leaders in the schools. Each school had to identify a science teacher or leader. That science leader would come to a Professional Development Session that I developed myself or with another small group. Here, I was building the capacity of the coaches to do different work. [The] Science facilitators’, which are the other group that I supervised, role was mainly as a project manager to implementing the [CSD] Math and Science Initiative. (Sandra, personal communication, December 20, 2007)

Sandra was building the capacity to implement the changes that she feels are necessary in science. Her drawing of effective professional development evidenced her feeling that the necessary changes in science are embodied by the CMSI, as the CMSI was what she drew a picture of.
Sandra worked at building leadership capacity because she believes that her teachers and CSD need more coherence:

When I started as a science manager, we had no coherence here. One of the things that the director decided to do was an inventory of all of our schools and the math and science materials they were using. We found 47 different instructional materials for science alone being used in our district. (Sandra, personal communication, December 20, 2007)

Coherence is important to effective science teachers’ professional development for Sandra (personal communication, December 20, 2007), and she returned to the necessity of coherence several times. This confirms the earlier notion as coherence was also important to The NSES professional development standard d, which states, that professional development needs to be continuously coherent (National Research Council, 1996) as can be seen in Figure 1.1. Sandra continued and explained how her district came to have 47 different materials. “One of the reasons for this is that we are a decentralized system, and our state has the law that schools make decisions about curriculum. So we had schools that were choosing science curriculum that was all over the place” (Sandra, personal communication, December 20, 2007). Sandra talked about how several different texts and materials were used for the same course across her district. Having multiple materials and a lack of coherence made it difficult for Sandra and her team to provide assistance for her science teachers. Sandra was not so worried about having various publishers’ materials; rather, she wanted coherence so that she would be better able to help teachers reach more students. If she held a workshop on teaching chemistry, she would not have the added variable of figuring out what resources a teacher may or may not have when they returned to his/her building.
With guidance from her new director’s survey, Sandra found that to provide effective professional development that she would need to find a way to provide some coherence in materials:

So we did this inventory and once we found out what we were actually dealing with, we realized that it was very difficult for us to get any kind of coherence or for us to effectively support them. There was no way five facilitators could support so many different curriculum materials in a systemic kind of way. Therefore, what we decided to do as a team was to look at standards-based instruction material. So, with myself as the science manager and the math manager, we went out to EDC, Educational Development Center, and at that time, they were showcasing NSF-supported materials like FOSS, STC; you know, all of those materials that were developed with NSF funds, and we decided that those were the materials that we were going to choose from and support. We took all of the materials, and we came back to CSD, and my team looked at all of the materials that fell under this category to decide which ones we were going to support and implement at that time. (Sandra, personal communication, December 20, 2007)

Sandra revealed that she believes that the National Science Foundation (NSF) developed materials would be among the best for CSD. She also revealed that she and the math manager went to the Educational Development Center (EDC) to learn more about the NSF materials. These two findings are important because they reveal that Sandra understood the importance of research-based materials in addition to simply providing coherence among materials for her district. The passage is also interesting because it reveals that Sandra believes that it is important to provide choices in materials for her leadership team to review. She did not just select one on her own. Rather, she and the math manager brought all of the NSF supported materials back to her district.

Sandra made the case for utilizing consistent curriculum materials and then introduced the idea that partners are important to the process of selecting the materials so “As we were going through this process, we invited university partners, a lot of the stakeholders, and others who I thought have a lot more insight to be part of that decision
“making” (Sandra, personal communication, December 20, 2007). Having university partners at the table for the selection process is important because this fosters the district and university relationship and transfers understandings of teachers’ teaching materials [content resources] into the professional development offerings if the university partners become professional development providers.

*Sandra presented an example of effective professional development.* Sandra provided an example of what she considers effective professional development: the [CSD] Mathematics and Science Initiative (CMSI). She drew a picture on the white board in her office to discuss the initiative. The CMSI is an exemplar of effective professional development for Sandra because the professional development experience is directly connected to what the teachers do in the classroom. She was able to provide an opportunity for teachers to come and learn how to do the science related to the kits and materials they had in their classrooms. The professional development experience relating to the classroom is the coherence box on the right side of the graphic that Sandra drew on the board. She believes that student achievement, the goal on the left side of the graphic, is attained through high quality teaching and learning. Further, Sandra believes that the high quality teaching and learning is influenced by three pieces: coherence (professional development that was connected to what teachers teach in the classroom), teacher quality, and more support policy (support from central office and from district policy).

The connection to the NSES professional development standard d (National Research Council, 1996), is again fairly easy to see with Sandra’s drawing including the word coherence (see Figure 4.2) as providing quality programs at all levels would require coherence. On a bit deeper level though, the case can be made for the connection to the
NSES professional development content standard b, which is integrating content, pedagogy, and students or learning to teach science (National Research Council, 1996). This is especially true when one considers how Sandra talked about coherence earlier by stating that providing common text resources and including university partners in the process of selection were both important for professional development. Further, the NSES content standard b can be considered central to effective professional development (see Figure 1.1), thus providing evidence that the district-level science supervisors will at times confirm the knowledge from the field of professional development.

Figure 4.2. Sandra’s drawing of the necessary components of effective professional development.

Sandra believes that effective professional development is not something that can be delivered by outside people in a couple of hours. “I mean, one of the things that [the
curriculum materials sales people] offered was, you know, we will come in and do two hours [of professional development]. Well, we know that is not effective professional development” (Sandra, personal communication, December 20, 2007). This comment is important because it reveals that effective science teachers’ professional development has to be more than a training session to learn about materials.

In thinking about how to overcome barriers to providing professional development that is well connected to the teachers’ classrooms, Sandra returned to an idea that she had put forward earlier in the interview. Sandra reiterated the necessity to solicit and build capacity for members of her staff to become the instructional leaders:

So the very first year, my team identified some potential teacher leaders. So they spied in on the professional development, and they looked for teachers who were asking good questions, who were aggressive and who showed all the signs of the teacher leader. Then, they engaged them in a conversation about starting a professional development leader’s organization and invite them to join. (Sandra, personal communication, December 20, 2007)

Not only is it important that she is actively recruiting new leaders, but it is also important that she mentioned that she engages them in a conversation and that she invites them to join. She went on to say, “for the past five years, in science, we have developed this model of professional development leaders. We actually do professional development for the professional development leaders” (Sandra, personal communication, December 20, 2007). This statement reveals Sandra’s perception that to be effective, the leaders need to have ongoing professional development as well as to provide professional development for teachers.

Emerging themes within Sandra’s individual case. Sandra believes very strongly that teachers’ professional development must be connected to what happens in the classroom (Sandra, personal communication, December 20, 2007). This is a common
theme among all participants, but Sandra offered a new perspective in that she said that teachers can attend an offering and then go back to a building with no support, and the principal will actually tell them that they cannot do science. Sandra also said that effective professional development requires money so “leech on to the money” (Sandra, personal communication, December 20, 2007). Effective professional development also involves coherence, teacher quality, and support.

The emerging themes in this case include: (a) money equals importance and effective district-level science supervisors will Maneuver to the Money to maintain an effective program, (b) Effective Professional Development Requires a Network of Leadership, and (c) Consistent Starting Points (curriculum materials and common standards) are necessary for effective science teachers’ professional development.

Southern United States School District. The third large district in this study is in the Southern United States. Southern School District (SSD) is a suburban school district that has over 150,000 students with a 74% graduation rate. The student body is 58% minority and 39% free and reduced lunch status. The 2008 average ACT score was 22.2, which was above the state average. In 2006, 84.6% of SSD students met Adequate Yearly Progress goals. SSD requires students to earn credit for four years of science in high school. SSD contains 16 high schools 20 middle schools. SSD teachers average 10 years of experience.

Susan. In terms of policy becoming practice, Susan is more connected to the policy side rather than the practice side, and she leaves a good portion of the detail work to her assistant:

While I may direct staff development initiatives, I have really put it in the hands of my instructional coach to actually see them for fruition to do the nuts and bolts
of getting staff support designed, developed, and delivered. So she becomes a critical part of the staff development conversation, but we are closely enough together that I feel like she is very responsive to the initiatives that I may have broadly defined, and then she is able to narrow it down and put it an action. (Susan, personal communication, July 17, 2008)

Susan revealed the importance of her science lead teacher to the science program at SSD. Other science supervisors held that their instructional coaches or science lead teachers were important, but Susan was different from the others in that she focused on more explicitly on the need to comply with national and state level science policy.

Susan previously worked on crafting and implementing national policy, which influenced her disposition and attention to national policy. Susan sees educational policy and law as the compass in deciding the direction of the science program and subsequent science teachers’ professional development in the district.

Her background in crafting and implementing national policy gives Susan a unique perspective to analyze effective professional development for science teachers. “This position requires the perspective of implementation as well as the perspective of law making, and that has been a huge advantage in that I have seen those worlds operate” (Susan, personal communication, July 17, 2008). Susan believes that her unique experience is an advantage to her as the science leader for SSD:

I think that my background is somewhat unique among my colleagues here in the curriculum offices. I have bounced from classroom to the policy world and back. I started as a classroom chemistry teacher in Fairfax County, Virginia, and spent my summers volunteering in D.C., grew up with the love of American government and the democratic process and volunteered for the White House, volunteered on the House side of the Hill, volunteered at a think tank one summer, and actually, one of these jobs turned into a full-time opportunity during the authorship of No Child Left Behind. (Susan, personal communication, July 17, 2008)
Susan's volunteering experiences with national policy issues and implementation is unique among the participants in this study. Susan felt that she had something to offer the policy world as a former teacher. She found a way to contribute by “joining the staff of a U.S. Senator, and I spent about three-and-half years working on education policy specifically but became more broadly aware and comfortable with domestic policy in general” (Susan, personal communication, July 17, 2008). Susan’s years spent working with educational policy is important because she shaped her understandings of effective science teachers’ professional development within the contexts of first adhering to policy. None of the participants held reckless abandon for policy (sans possibly Loren as will be discussed later), but Susan’s connection to policy was more evident than other participants.

After working fulltime with a U.S. Senator’s staff, Susan returned to teaching and then went back to Washington D.C., this time to work with Presidential initiatives:

So as time went along, my husband had a job opportunity here in SSD. We picked up, relocated; I went back to the classroom, and I taught in [another] county. At this time, I taught physical science. Really, it was about two-and-half years after being here that I had the opportunity to return to D.C. I got a call from the White House and worked on one of the President’s staff development initiatives to support teachers as they respond to the changing demands and accountability. (Susan, personal communication, July 17, 2008)

This reveals that Susan has a work history that changed from the policy world to teaching multiple times. Susan summed up her experiences as being “really exposed to what a true nationwide domestic policy implementation looks like, and it was a great educational experience for myself” (Susan, personal communication, July 17, 2008). Each time, she had opportunities to learn about science education from different perspectives.
As Susan worked on the Presidential initiatives, she noticed that communication to teachers was poor; “I worked in the environment and recognizing that in the implementation of a new accountability system, the communication to teachers was limited and needed some very close examination” (Susan, personal communication, July 17, 2008). Communicating policy changes to teachers is a prerequisite to delivering effective science teachers’ professional development for Susan.

Susan returned to education and felt that she had learned much from her experiences:

So really it didn’t conclude entirely, but the funding was limited. I had other opportunities to stay at the Department of Education, but I am not really a bureaucrat. I love the implementation of law, implementation of policy, so we returned to our home here, which stayed here furnished, as I was gone for that bit of time. I have been in this position from there. So I kind of feel like it’s been a bouncing background, but this position requires the perspective of implementation as well as the perspective of law making, and that’s been a huge advantage that I have seen those worlds operate. (Susan, personal communication, July 17, 2008)

This passage reveals that Susan believes that successful change would require not only an ability to implement, but also an understanding of policy issues and the law-making process. Further, she feels that she has an advantage in her position as science supervisor because of her past experiences.

Susan drew effective and ineffective professional development. Susan believes that effective science teachers’ professional development has to be balanced, which can be seen in Figure 4.3.
Susan was the only participant who showed a facilitator doing a handstand on a demonstration table, but she felt strongly that the professional development facilitator should make extraordinary efforts to get the message across, and she said that was “supposed to show the forces of balance” (Susan, personal communication, July 17, 2008). Susan wrote words next to four arrows in her drawing to explain the forces that must be balanced: “Research, content, data, and instruction and activities” (Susan, personal communication, July 17, 2008). Interestingly, all of the arrows in Figure 4.3 point to the facilitator. To Susan, this means that the facilitator needs to be cognizant of and incorporate all four areas while delivering the professional development for it to be effective.

During the interview, Susan defined ineffective professional development as boring and not well-connected to what science teachers actually do, and her drawing of

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*Figure 4.3. Susan’s drawing of effective professional development.*
ineffective professional development confirms that her view of ineffective professional development was boring, which can be seen in Figure 4.4.

Figure 4.4. Susan’s drawing of ineffective professional development

The participants occupy similar desks in both of Susan’s drawings; however, the participants have their heads down on the desks in the ineffective professional development drawing (Figure 4.4). Susan’s ineffective professional development drawing also does not have a participant standing up, whereas at least two individuals are standing in Susan’s effective professional development drawing. Another difference in Susan’s two drawings is that the participants in the ineffective professional development drawing (Figure 4.4) do not have marks around their heads as they do in Figure 4.4, the effective professional development drawing. The marks around the participants’ heads in the effective professional development drawing signify active learning for Susan.

Susan made the point that there must be a balance of adult learning and adults assuming the role of students and learning as their students do for effective professional development for science teachers:
I think that a high quality staff development looks very similar to a classroom that is engaged with students, and yeah, we do need to recognize that adults learn differently, but for the most part, the images would be similar. Here I am trying to demonstrate that there is a balanced approach, yet it’s got to be corky and crazy just like it would be for kids. (Susan, personal communication, July 17, 2008)

To be effective, professional development has to be balanced between opportunities for teachers to learn as students and as adults do. Susan revealed that effective professional development holds characteristics in common with effective teaching, but there are important differences for adult learning. This is part of the balance that Susan espoused as important:

You know, your balanced approach comes from your content, your instruction, or instructional practices, which I include in activities data and research, and you have active engagement, and you have people attentive; you have participation, and you have involvement. (Susan, personal communication, July 17, 2008)

Each subset of balance is important to Susan. She explained what she meant by active engagement by saying that “participants are talking, they are doing, they are reflecting, they are writing, they are participating. What I would not want to see is direct instruction from a staff developer, who is lecturing on how to teach” (Susan, personal communication, July 17, 2008). This is important because as Susan was describing active professional development, she also revealed her disdain for ineffective and lecturing professional development providers.

*Goals and vision for effective professional development.* Susan holds that the worlds of educational policymakers and practitioners needed to blend:

I often say there are too few teachers who leave the confines of the classroom in order to influence the policy-making process, and there are too few policymakers who have had the privilege of returning to the roots and putting themselves in midst of the classroom in order to get exposed to the daily routines and expectations of a traditional classroom teacher. (Susan, personal communication, July 17, 2008)
She feels that this vacillation of experience (like hers) is important to setting and implementing policy that would yield effective professional development for science teachers.

Providing more guidance for district-level curriculum supervisors, Susan tackled her thought process of responsibilities to implement policy:

What actually unfolds is that my responsibilities tend to become much more of that awareness of policy and how does it successfully get implemented in a K-12 Science Program. How does it relate with larger policy priorities, and of course, how do we stay in compliance with the law, and what are we doing to avoid any type of non-compliance? So there are obviously layers of policy knowledge and awareness that may reprioritize something that I would naturally prioritize differently. (Susan, personal communication, July 17, 2008)

This reprioritization of her plans is important to help understand that above all, Susan relies on policy to guide professional development. Susan stated that content standards are paramount among all of the guidance regarding what to pay attention to when cultivating professional development, including “always want[ing] to emphasize the standards that are being addressed.” Standards for Susan represent the roadmap to implementing policy.

Emerging themes in Susan’s case. Three emerging themes from Susan’s case include: (a) effective science teachers’ professional development must be Balanced in two ways. It must be Balanced in terms of delivery where the teacher has opportunity to learn as adults do and as students do. Effective science teachers’ professional development must also be Balanced among content, research, data and instruction and activities; (b) effective science teachers’ professional development will be Guided by Standards and Bound by Policy and Law; and (c) future science teacher professional
development will be affected by how well *Policy Changes are Communicated* to science teachers.

**Smaller Urban Districts**

The smaller urban districts all have between 30,000 and 100,000 students. Each district was selected because of size and convenience. The researcher met two informants from the smaller urban districts at the Urban Science Education Leadership conference held in conjunction with a 2007 National Science Teachers Association area conference in Denver. The third informant was selected out of convenience as she attended several conferences in common with the researcher and is located near the researcher. All three informants are located in different states.

**Midwestern United States School District 1.** The first smaller urban district in study is in the Midwestern United States. Midwestern School District 1 (MSD1) has over 30,000 students. In 2007, MSD1 had a 74% graduation rate, which was less than the state’s 91% graduation rate. The student body is 37% minority and 52% free and reduced lunch status. Science performance data was not available, but 55% of MSD1 students are proficient in grade 11 mathematics. MSD1’s grade 11 mathematics test performance was less than the state’s, which has 78% of students proficient. MSD1 requires students to earn credit for two years of science in high school. MSD1 is comprised of over 60 schools with 5 high schools and 10 middle schools. MSD1 teachers average 14 years of experience.

**Loren.** Loren began her career in a science lab and moved into education. “This is my eighth year in education. I started off with a degree in biology, worked in a lab for about a year, which is what I said that I wanted to do” (Loren, personal communication,
November 30, 2007). After working the lab for a short time, Loren realized that she was not happy “And, very quickly realized that it was more production than it was research and development. It was very boring frankly. So I went back and got a teaching certificate” (Loren, personal communication, November 30, 2007). With her lab experience and science degree, Loren came to education with a strong background in science.

Loren taught high school science for five years and was in her third year as district-level science supervisor. She described her career path in education:

I student taught actually here in MSD1 at an urban high school which was very diverse, high free and reduced lunch, high minority population, probably the most diverse population in the city. I really enjoyed it and went to the Northern suburb to teach for five years. I taught high school Biology, AP Biology, Anatomy and Physiology, and then . . . my former curriculum director called me and made me aware of this position. I had been working on my administrative endorsement, had finished my Master's degree, and she knew I was interested in getting into this kind of work so I applied and got this position. That was three years ago, so I came straight from the classroom to what is considered to be an administrative position. (Loren, personal communication, November 30, 2007)

Loren revealed that she became aware of the science supervisor position because a former curriculum director called her. She also revealed that she had a shorter time in the classroom than some of the other participants.

Loren decided to apply for her position because of her experiences in working with educators. “At a young age, even as a first year/second year teacher, I was part of a first class of teachers who were falling into the class of [state] teaching standards” (Loren, personal communication, November 30, 2007). Loren described the state teaching standards as an evaluation system being “A new way, a very different way of evaluating teachers. It was a portfolio creation with multiple applications over consecutive days. It was just a very different way of doing things” (Loren, personal
communication, November 30, 2007). Loren found a way to contribute and help others understand the new way to do things by presenting the state’s new standards-based evaluation system to teachers. Her involvement with this new standards-based evaluation system is important because there was a disconnect with content standards even though her entry to district-level work was based upon implementing a standards-based evaluation system.

Loren explained more about the standards-based evaluation system, her involvement, and how she was invited to work with teachers to help them understand the new teaching standards. “So my principal approached me and asked me if I would work with teachers in my building. To help them, you know, the veteran teachers, to help them become more comfortable with the teaching standards” (Loren, personal communication, November 30, 2007). Loren found herself helping veteran teachers understand the new way of doing things and had some success. She went on to describe her entry into delivering science teachers’ professional development:

That kind of escalated into . . . designing problem solving workshops, and just, I really enjoyed working with teachers in a professional development capacity, and that's kind of what I need this job to be is working with teachers in a professional development capacity. So [this job] is that. (Loren, personal communication, November 30, 2007)

Loren views the district-level science supervisor position as working with teachers and their professional development.

Loren also enjoyed that her position was in science, “But it is specific to science, which is what I like so it [science] can be my main focus, and that's what I like because I still have a very deep love of science content” (Loren, personal communication, November 30, 2007). Her work with teachers and mention of standards at the beginning
of the interview did not carry through to the rest of the interview or document review. This fact is interesting given her entry to the science supervisor position was so dependent upon her understanding and ability to communicate the new state standards for teaching.

Loren holds specific beliefs about effective and ineffective professional development. She is very focused on sustaining professional development over time and embedding professional development within the context of classroom practice. While she maintains teachers as professionals, her district missed opportunities to connect professional development to standards. This finding is counter to professional development literature (National Research Council, 1996; National Staff Development Council, 2001), but was only present in Loren’s individual case. The absence of a focus on standards that was apparent from the interview was also found in the document review for Loren’s district.

For example, the district’s Professional Development Activity Proposal: Conceptual Physics (Midwest School District 1, 2007a) form required Loren to outline several details regarding a proposed professional development offering for MSD1 teachers, but not once in the two-page application did it require standards. Likewise, the Elementary Science Professional Development Plan (Midwest School District 1, 2007b) was void of standards language. Loren also posited that one document that mentioned standards, The Professional Development Proposal Physics Certification (Midwest School District 1, 2007c), was viewed as “Controversial” (Loren, personal communication, November 30, 2007), and she reported that the professional development did not go well. Interestingly, this was one of the documents that showed an intimate
involvement of a university partner. The other partners found in the document review and interviews were vendors: organizations that provided support for a product or teaching resource, such as CPO science.

Loren revealed other missed opportunities to connect to standards as standards were mentioned only on one of 26 slides from a slide presentation for curriculum mapping as a Sample Quality Lens. It seems that it would be hard for teachers to make the connection to the importance of standards if the standards were only used as a lens. All of this is noteworthy and perhaps misaligned given that the professional development goals for MSD1 include “Provide on-going, content-based professional development for teachers to update their skills” and “Content-specific professional development for teachers” (Loren, personal communication, November 30, 2007). With the focus on content for professional development as outlined in the goals, one would expect to find a more explicit connection to the standards in the document review. How are teachers to translate content learning from the professional development experiences to the classroom?

Loren found that she was the leader in deciding the direction of the science program in the district. When asked about what provided the vision and mission for professional development in her district, Loren replied, “Myself and cardiac data” (Loren, personal communication, November 30, 2007). For example, she stated that she does not get any direction from the superintendent, “No real direction from above, except a half-day curriculum day reserved for science” (Loren, personal communication, November 30, 2007). Having no real direction is troubling and a break from common accepted literature (National Research Council, 1996; National Staff Development Council, 2001);
however, Loren revealed the trapping of science professional development is that there is not a clear vision for professional development from the district level except from her. The district identifies one-half day for science professional development but gives no explicit goal or expectation for an outcome. The district relies upon Loren to maintain the leadership for professional development but does not provide significant measures for her to utilize. The cardiac data is driving the vision. What if this cardiac data is wrong?

Loren provided a copy of a school improvement diagnostic worksheet (Midwest School District 1, 2006), in which one section specifically addresses professional development. The diagnostic worksheet indicates glaring issues for effective professional development in the MSD1 and its schools. Consider one of the included statements: “There is no formal building PD [professional development] plan” (MSD1, 2006). Other statements included were “Teachers do not understand the rationale for multiple PD initiatives” and “Lack of clear communication and expectations for team meetings for PD and curriculum development” (MSD1, 2006). The statements in these documents show a lack of focus on content standards, which could be an easy fix. Grounding professional development in standards would provide focus and clarity for the district’s professional development and for the involved teachers.

MSD1 is admittedly lacking in some in significant pieces of guidance for Loren— as can be seen in the diagnostic worksheet (MSD1, 2006). As such, they, and she, rely upon her cardiac data to guide the district. Loren intuitively aligned the district well with two of the NSDC (2001) professional development standards – context and process. However the district lacks a connection to content standards-based professional development by relying on her cardiac data. In this case, aligning two (context and
process) out of three may not good enough as the district lacks a consistent direction for its professional development (MSD1, 2006).

**Loren’s drawings.** Loren’s drawings reveal that her perception of effective professional development must include partners, as can be seen in Figure 4.5. She drew a partnership of general education, special education, and higher education working with teachers at a table. In contrast, in Figure 4.6 she drew a single general education person working with teachers in a lecture setting. She also stressed importance of a variety of delivery methods and tools with her drawing. Consider the four items on the demonstration table in front of a chalk or white board (flask, graduated cylinder, microscope, and computer), which are science tools that are not present in Figure 4.6.

The position of the facilitators in Figure 4.5 is also relevant. They are standing, but they are not tied directly to the board or the presentation/demo unit in the front of the room. Further, the same materials are available to the teachers at their tables as appeared on the demonstration table minus the computer.

![Figure 4.5. Loren’s drawing of effective professional development.](image)

Perhaps it was unintentional, but Loren also left two open tables in her drawing of effective professional development (see Figure 4.5). In the ineffective professional
development drawing, all chairs are full (see Figure 4.6). During the interview, Loren noted that one barrier to effective professional development is having too many people. She stated that having 200 people in the room for a lecture-style professional development offering is not effective (Loren, 2006). Even the ratio of professional development providers to teachers is insightful as to what is effective in Loren’s view. Consider that the ratio of facilitators to teacher in the effective professional development drawing is three to two, while the ineffective professional development drawing shows one facilitator to three teachers.

![Figure 4.6. Loren’s drawing of ineffective professional development.](image)

Loren’s ineffective professional development drawing (Figure 4.6) shows that the facilitator is directly tied to the white or chalkboard and positioned directly in front of the participants. Interestingly, she drew the facilitator almost in the way of the message on the board, and the arrow from the facilitator indicates that the facilitator is in total control of the learning. The participating science teachers are there to simply receive the
message, and they have no materials to interact with. Loren did not even give the participating teachers a desk to work on; they only have a chair to sit in. Figure 4.6 could be a classroom or auditorium.

*MSD1 emerging themes.* Learning from this individual case is a bit more puzzling than some of the other individual cases. The lack of focus on and inattention to standards is unique to this individual case. While Loren’s entry to professional development and her position are based on the implementation of teaching standards, the document review and interview reveal a lack of focus on content standards for professional development within MSD1. This represents a small, but potentially significant departure from current understandings of effective professional development given that the National Staff Development Council (2001) identified content as one of three major components of effective professional development and that many of the studies included in the review in Chapter 2 reference content or as a word to describe a component of effective science teachers professional development. This anomaly will be addressed in the next chapter. Even with this anomaly, there are still important emerging themes from this individual case. The emerging themes include: (a) science teachers’ professional development is not effective when there are *Too Many Participants* for the facilitator, (b) *Partnerships* are necessary for effective professional development, and (c) district-level, curriculum supervisors need to pay attention to partners’ guidance and suggestions (*Listen to Partners*). Loren and MSD1 had guidance from university partners that went unheeded. Some of that guidance was showing the importance of standards (MSD1, 2006).
Pacific Northwestern School District. The second smaller urban district in this study is in the Pacific Northwestern United States. Pacific Northwestern School District (PNSD) has over 45,000 students with a 70% graduation rate. The student body is 57% minority and 41% free and reduced lunch. Thirty-seven percent of 10th grade PNSD students met state standards. PNSD requires students to earn credit for two years of science in high school for graduation. PNSD contains 12 high schools and 9 middle schools. PNSD teachers average 11.9 years of experience, and 98% of PNSD teachers are highly qualified.

Bonnie. Bonnie was different from many of the other participants in that she does not have a science background. “I was assistant principal for four years, and that's where I became involved in science. I don't have a science background like you probably do. I just took some classes in college and, of course, in high school” (Bonnie, personal communication, December 17, 2007). Bonnie relies upon her science lead teacher because she lacks a science background. Her current lead teacher, Michelle, is not the first lead teacher she had worked with. “I was there when we hired somebody part-time then she left, and we were able to hire this person, and she came with a lot of background and expertise, and she had been a lead teacher for 12 years” (Bonnie, personal communication, December 17, 2007). Through drawing attention to the expertise and years of experience of her lead teacher, Bonnie evidenced that she feels these things necessary for her job. Further, Bonnie insisted that Michelle, PNSD Science Lead Teacher, also be interviewed.

Bonnie explained more the path that led to her becoming a district-level science supervisor after she spent about four years working with a grant effort:
I went on to be a principal for two-and-a-half years, and then the project director [of the grant] came to me and said, “I got a job so I want you to take my funds.” So I was acting [director of the grant], and then I applied for [the district-level science supervisor position], and I got it. (Bonnie, personal communication, December 17, 2007)

Bonnie was in her fourth year of being the district level supervisor at the time of the interview. Bonnie relies upon her support staff for the science content and to help form the overall direction for science and professional development in PNSD. Michelle, the science lead teacher, is the person with the most insight for the professional development in PNSD and is a key informant in this individual case. This is the only case to include two key informants. The other cases include other informants but not more than one key informant. The decision to include two key informants in this case was made because of the shared leadership role that Bonnie and Michelle held.

As a key informant, Michelle’s drawing of effective and ineffective professional development (Figure 4.7) is included in the data. Figure 4.7 reveals much about Michelle’s understandings of effective professional development. The words Michelle uses shows that standards are important and so too are the teachers’ collaboration and discussion. Michelle was the only one to include science tools or paraphernalia in the ineffective professional development drawing. Both sides of Figure 4.7 have Erlenmeyer flasks; the ineffective professional development side shows the facilitator holding the flask while the effective professional development side of the drawing shows the participating teacher holding the flask. The active involvement of the teachers is consistent with the intentions of the National Science Education Standards B and C, “Learning to learn science,” and “Learning to teach science” and also consistent with the document review for PNSD.
Two PNSD documents corroborated the idea that science teachers’ professional development needs to be focused on learning science and learning to teach science.

Consider that the *Professional Teachers of Science: Summer Institutes* document includes language from the National Science Education Standards stating, “Each course will provide the participating teacher with a multi-faceted professional development experience of learning science, learning to teach science, and learning to learn” (Pacific Northwest School District, 2008). This language is consistent with all of the National Science Education Standards professional development standards that were discussed in Chapter 1: (a) learning science; (b) learning to teach science; (c) learning to learn; and
The Professional Teachers of Science: Summer Institutes document also stated:

Teachers will learn science by making explicit connections to standards documents [emphasis added], summaries of research on student learning, and exemplary student curricula. Teachers will learn about their students’ thinking and about their own teaching by improving their skills in using formative assessment and student work. (Pacific Northwest School District, 2008)

Importantly, PNSD reveals that the content expectations for effective science teachers’ professional development include making connections to standards and thinking about teaching. The second document, Five Year Strategic Plan: High School Science, the shared vision is stated in bold: “We value science by inquiry. We value equitable opportunities for scientific growth. We value scientific literacy” (Pacific Northwest School District, 2006). In the Five Year Strategic Plan: High School Science, a case can be made that placing value on scientific literacy would necessitate learning science consistent with NSES standard a and that placing value on equitable opportunities for scientific growth is consistent with NSES standard b (National Research Council, 1996).

The finding that these documents contain language consistent with NSES professional development standards is evidence that the standards remain important.

The Five-Year Strategic for Plan High School Science document also contains several goals for professional development. One is, “All teachers will participate in ongoing, appropriate professional development that is truly professional and that offers new and supportive thinking to enrich their knowledge of science content [emphasis added] and pedagogy [emphasis added]” (Pacific Northwest School District, 2006).

Again, learning science and learning to teach science are important, but what does PNSD
mean by providing truly professional, professional development? The document holds that only experts will lead the professional development experiences – “Skilled Science Coaches/Consultants, Lead Teachers, and regional, state, and national experts will teach the courses” (Pacific Northwest School District, 2006). This goal shows the intention to utilize partners to deliver professional development, and the partners have to be skilled in some way. This is important because if a district wants a skilled cohort of individuals coming from training, the district must provide the opportunity for that cohort to become skilled. It also introduces the idea that effective professional development needs to be ongoing because of the use of the word courses, as one would not expect a course to be short in duration. Further, the word is plural which indicates the need for more than one sustained effort.

Bonnie stated one barrier to effective professional development is the teachers’ perceptions of their ability by stating that “this is not easy, and I think changing high school’s going to be tougher because they don’t see themselves as needing help” (Bonnie, personal communication, December 17, 2007). Bonnie suggested that the way to overcome the teacher perception barrier is to win over both the teachers and administrators and then build partnerships with the community to support her initiatives with actions and support. Actions mean that community members such as area scientists and university partners would actively participate in her teachers’ professional development, and other community partners would support the initiatives with funds.

An observation of a professional development offering also suggests that effective partnerships are important to PNSD in that the professional development offering takes place at a local university and is led by a physics professor. This is distinguishing
because not all of the participants made such an explicit connection to a university. During the observation, teachers came to the university to work on their science teaching projects. The professional development is one of a co-led series of meetings. Michelle teamed up with a university professor (Clayton) to lead the sessions. The observed session was completely led by Clayton. During the observation, 14 high school teachers were in four small groups learning about physical science.

The group working on understandings of force and motion referred to the following books: *NSES Standards*, *Science Matters*, and the *Atlas*. Each of the books utilized by this group is commonly used material to help teachers understand content standards. This small group of four was engaged in a curriculum topic study while Clayton, the university partner, circulated the room. When he interacted with this curriculum topic study group, he asked them questions to help guide their study.

Bonnie was also passionate that, to be effective, high school curriculum has to be based in content standards, which provides background as to why her professional development is rooted in standards and standards language. She also expressed frustration with leadership:

> I get frustrated because with the voice you are talking about the shyness - the lack of interest - among high level leaders in education of science that it [science] is not in their background, and it's really frustrating after a point where you want to hit your head against the wall; I mean, you just want to pull your hair out because you just don't understand; why don't they get it? (Bonnie, personal communication, December 17, 2007)

This frustration is interesting given that Bonnie does not have a strong background in science. However, even with her limited science background, she still sees opportunities lost for science education and is deeply troubled by the missed opportunities.
She continued to explain her frustration with leadership saying,

But they come in these jobs, and they have a very short window maybe to be successful and so they want to run with what they know, and people are just obsessed with the [teaching of] reading thing; it's absurd. I mean, where is the common sense; what happened to common sense? (Bonnie, personal communication, December 17, 2007)

Bonnie’s disdain did not end there:

They had us read Sustainable Leadership by Fink and Hargreaves, and I started reading the first three chapters. I said, this is just about common sense and being respectful and giving support, learning yourself, making sure that you learn well and making sure you have good advisors. I mean, that's all it's about; it's not magic; it's not rocket science. But we get a lot of barriers that we shouldn't be dealing with; we shouldn't have to deal with this many barriers, and what I call barrier people. (Bonnie, personal communication, December 17, 2007)

With that comment, she was the first to name higher-level leadership folks as “barrier people” (Bonnie, personal communication, December 17, 2007). Bonnie was very passionate as she spoke about the lack of common sense that barrier people had.

Bonnie provided an example of a barrier person describing him as “actually one of our science leaders because he was very stuck in an old paradigm and all the money was going to high school; nothing was happening for elementary” (Bonnie, personal communication, December 17, 2007). Barrier people bother Bonnie, and she expounded on the problem of them by talking about her experience in elementary teaching. “I mean, when I taught elementary, I almost never touched science” (Bonnie, personal communication, December 17, 2007). The problem for Bonnie when she was teaching elementary was two-fold. She did not like the curriculum materials, and she did not feel supported by superiors.

Emerging themes in PNSD. When asked about how she views the delivery of professional development in PNSD, Bonnie stated, “We are constantly pushing to the
edge; we are constantly bending over backwards for the teacher; we deliver to the teacher; we walk the talk; we try to deliver more than we promise” (Bonnie, personal communication, December 17, 2007). Bonnie and Michelle are both passionate about professional development in their district. The emerging themes from this individual case include: (a) progress will take Time even with effective professional development, (b) Barrier People exist that hinder effective professional development, and (c) Partners are important for effective professional development.

**Midwestern United States School District 2.** The third smaller school district in study is also in the Midwestern United States. Midwestern School District 2 (MSD2) has over 34,000 students with an 82% graduation rate. The student body is 23% minority and 42% low income. Eighty-two percent of MSD2 students met state standards, which is below the 87% state average of students meeting state standards. MSD2 requires students to earn credit for two-and-one-half years of science in high school. MSD2 is comprised of over 50 schools and has 6 high schools and 10 middle schools. MSD2 teachers average 15.5 years of experience and 98% are highly qualified.

**Clara.** Clara’s face seemed to beam as she talked about professional development for her teachers. She seemed excited to talk about the professional development plan for MSD2. There was a lot more to this individual case, but to Clara, professional development is effective when “Teachers can see the value in the professional development, see the purpose or the reason for having it” (Clara, personal communication, January 30, 2008). At the time of the interview, Clara had “been in this position for 10 years and prior to this time, I was a high school biology teacher” (Clara, personal communication, January 30, 2008). Clara didn’t really think that she wanted to
be a district-level science supervisor, but she had people close to her who encouraged her to apply for the job. When she reached a point in her career that she thought about doing something different, the district-level science supervisor position was open:

I had reached the path in my career where I was looking to do something different, and I was with a different system; I was with a parochial system here in the city. Then this job was advertised and further, this will sound strange, but many years ago, my husband made the comment to me that this job is a job that's just made for me. So he made that comment many years ago. Then many of my friends who work for MSD2 contacted me and asked me to apply. At that time, this position was advertised as a teacher coordinator or something to that effect. So after teaching all those years, I applied, and I did not expect to get the position, but I did. I kind of came into it in an unusual way. (Clara, personal communication, January 30, 2008)

Clara felt that her path was unusual because becoming a district-level curriculum supervisor was not an initial career goal for her.

The structure of her district is such that her boss is the director of curriculum and professional development. Clara mentioned that the “Two departments had been merged” (Clara, personal communication, January 30, 2008) in her district. She also said that she and about ten of her colleagues spent a lot of time discussing professional development. MSD2 reserves the equivalent of 1,000 teacher days per year for professional development for the middle and high school teachers. This means that all disciplines share a part of the 1,000 days for teacher professional development.

In her drawing, Clara chose to represent professional development with arrows and letters. In the drawing representing effective professional development, all of the arrows, except one, go in two directions. This is in stark contrast to the drawing on ineffective professional development, where there is only one arrow and it is unidirectional – from the presenter to the teachers. The effective drawing for Clara represents a model that includes time for feedback. Clara feels that “[professional
development] is effective when there is smart interaction going on with the presenter” (Clara, personal communication, January 30, 2008). Smart interaction meant a reciprocal learning opportunity for the teachers involved in the professional development offering. The multi-directional arrows represented feedback in the discussion or interaction with ideas and concepts.

The effective professional development model for Clara appears to be centered on the presenter. She explained that the presenter could just as well be on the side of the drawing, but that it is important that the teachers interact, have dialog with the presenter, and gain feedback regarding content or teaching methods and have time to interact with each other.

She also explained that there are times when the ineffective model is necessary. “I think [professional development is] ineffective, when there is just one-way communication with the presenter just talking and talking and talking. I realize there are times when you do safety and things like that, but you, know it's hard” (Clara, personal communication, January 30, 2008). It was a bit puzzling that she said that the ineffective model of professional development is necessary. She described the necessity of providing ineffective professional development for safety training. This is important because she was talking about the necessity to train teachers on certain things like safety. In the case of keeping with district safety protocol, she feels that there simply is not a way to provide what she considers effective professional development. Clara revealed here that she believes that ineffective science teachers’ professional development is didactic, unidirectional with the facilitator working from a script.
Figure 4.8. Clara’s drawing of effective professional development.

Figure 4.9. Clara’s drawing of ineffective professional development.
Perhaps MSD2 has a legal reason for this, but it seems that her model of effective professional development like the one that she drew could have enhanced portions of her safety training.

Clara’s drawings do not show that multiple presenters or facilitators are important. She has one professional development facilitator (presenter or “P”) in each drawing (see Figures 4.8 and 4.9). Interestingly, the only individual that is not represented with a letter is the presenter in the ineffective professional development drawing. All other individuals are represented with a single letter. This gives the impression that the presenter or facilitator is inappropriately more important in ineffective professional development. So Clara understands that the content of professional development is more important that the professional development provider or presenter.

_A Guide to Curriculum in MSD2_ is a document that Clara provided that identifies goals for students, curriculum areas and specific programs. Interestingly, the first goal for students does not include science: “Demonstrate competency and fluency in the essential skills of reading, writing, speaking, listening, and mathematics” (Midwest School District 2, 2007a). At the time of publication, the state required only local testing and not statewide testing in science.

Goal three addressed science: “Understand the important ideas from the arts, humanities, sciences and mathematics and understand the relationships among them” (Midwest School District 2, 2007a). The focus on only the understanding of ideas and relationships and the void of a focus on the ability to demonstrate competency and fluency [abilities to do science] is not consistent with portions of the interview with
Clara. One could deduce that only the interaction with ideas (content) is important from the drawings of effective professional development, but the interview and other artifacts reveal a different story.

For example, several of the flexible but required professional development offerings have the science teachers working directly or in small groups, no more than five or six teachers to one, with a scientist where the teachers would get hands-on experiences (Midwest School District 2, 2007b). Other available sessions, according to the Science District Staff Development for High School Teachers, include opportunities to learn about using science equipment, using micro-scale techniques for chemistry, GIS (Global Information Science) applications with field time and hands-on experiences, lab demonstrations, and a session on kits and inquiry (Midwest School District 2, 2007b). Further, the document A Guide to Curriculum in MSD2 also stressed process skills as a goal for the science program, “The program stresses hands-on activities to develop inquiry and thinking skills, as well as science process skills” (Midwest School District 2, 2007a). Clearly, MSD2 maintains both understandings of science (content) and abilities to do science (process) as important.

Clara reported that MSD2 requirements for science teachers’ professional development were embedded within the school year and contractual obligations. MSD2 requires all teachers to log seven hours of professional development during the course of a year outside of normal duty hours and prepaid the teachers for their time. Clara views the requirement as supportive and appreciates not having to process the paperwork for her teachers’ extra pay after the district-required professional development offerings. She only has to have her secretary keep track of attendance. If a teacher does not fulfill the
requirement, they are docked on their paycheck. With this situation, Clara feels compelled to provide quality professional development for her science teachers. She believes that flexibility and options are important in professional development offerings:

I think that the fact that we have the flexible time and where teachers can choose which ones they would like to go to, it's possible for teachers to complete all of their flex time during the summer then they won't have to do any during the school year. It's possible for people to do it online through the NSTA's SciPacks. There are so many options, and I think one thing that's unique to MSD2 is the options that we have available. (Clara, personal communication, January 30, 2008)

In addition to the interview evidence that MSD2 allows flexibility for teachers to complete required professional learning, the artifacts Clara supplied also support the idea to provide flexibility in professional development offerings for her science teachers.

An example of this flexibility was found in the Science District Staff Development for High School Teachers document as it includes eight prearranged offerings and one contractually required offering (Midwest School District 2, 2007b). MSD2 science teachers are required to pick one of the eight other offerings in addition to the contractually required offering. In addition to providing choice of different offerings to her science teachers, Clara is also flexible with teachers’ time. Some of the offerings could be completed during the summer or on their own time as with the Sci-Pack. A Sci-Pack is a National Science Teachers Association asynchronous, interactive, and online module regarding specific science content and rooted in the National Science Education Standard’s content standards.

Clara revealed that time is a barrier to effective professional development by describing MSD2’s 1,000 days for professional development:

So we have a 1,000 days allocated during the summer for those areas that are implementing new materials. When I was implementing the science during the
summer, when I brought in those teachers with seven and half hours that was part of the 1,000 days and those teachers received their daily rate of pay, it was not part of flex time, and I think that's really unique. The reason we do is because, you know, there is not always enough time; two-and-half hours is too short. (Clara, personal communication, January 30, 2008)

With this, Clara presented two issues of time. One is to be respectful of teachers’ time, and the other is that effective professional development needs to be sustained over time.

Clara is respectful of teachers’ time by being flexible with professional development offerings, and Clara identified the need for sustaining professional development several times in the interview. Clara also commented on what happened for new secondary science teachers:

We have approximately ten new secondary science teachers, and the way we do things here is in August, we will have curriculum day and a couple of days where the curriculum specialists get to visit with the new science teachers. I try to find out exactly what the teachers' names are and what they are going to be teaching. I will have them for a three-and-a-half hour session and talk about the district and what we have to offer. (Clara, personal communication, January 30, 2008)

Clara again framed the professional development in the context of time. She then talked more about the three-and-a-half hours that she is responsible for out of two days of training time for her new teachers:

Then I break them into small groups based on what they teach. If they teach Geoscience, I will have a Geoscience teacher, with the textbooks, go into how they organize the classes. Another group is biology teachers, so I will have the [new] teachers interact with me and then with pair of [experienced] teachers. I ask the chairs to help recommend good teachers they should visit with, because people there [at the building] are crucial. (Clara, personal communication, January 30, 2008)

Clara meant that learning the ways of the building is crucial, but by her pairings of the new teachers with trusted content area teachers, she revealed that she also believes that content resources are important for her new teachers.
Clara makes sure that the pairings will be as beneficial as possible by selecting only trusted veteran teachers to work with the new teachers. “I also visit with these people [the department chairs and veteran teachers] ahead of time to let them know what I would like them to do. Everybody, of course, is reimbursed for all this” (Clara, personal communication, January 30, 2008). This is also another example of how Clara respects her teachers’ time. She pays them. She also interjected an “of course” in her interview response as if she were mentoring the researcher instead of giving an interview.

Clara continued with the discussion, and the necessity of paying the teachers for their time was repeated several times:

And then I followed that up with a half-day, where the teachers meet privately with their chair or liaisons in their schools, and there they can give them, you know, special help in a small group. So it's a half-day with me and the teachers, and a half-day with their other person. And then the district will let them spend one half-day in their room getting ready, and then they will be reimbursed for that. (Clara, personal communication, January 30, 2008)

Here again, Clara returned to the necessity to pay teachers for their time.

*Emerging themes for Clara.* Clara values and respects the teachers in MSD2. She wants the teachers to be able to see the purpose and value in any professional development offering they attend. She also relies upon science standards to provide direction for science teachers’ professional development in MSD2. The emerging themes for this individual case include: (a) **Effective Professional Development Will be Sustained Over Time**, (b) **Effective Professional Development is Active and Will Foster Interaction With Peers and Professionals**, and (c) **Successful District-Level, Science Supervisors Will Respect Teachers’ Time by Paying Teachers for Their Time and by Incorporating Flexibility in Time of Providing Professional Development Offerings**.
Emerging Themes within Clusters of Size

The six districts included in this study each have key informants. The districts and data gathered from the districts are organized into two clusters. One cluster includes data from districts with over 100,000 students. The other cluster of districts includes data from districts with 30,000 to 100,000 students. The data is clustered in this manner because it is convenient and the context of the two clusters is different. For example, the smaller urban districts only have a science supervisor and possibly a lead science teacher, while the larger urban/suburban districts have science supervisors and a science leadership team - i.e., multiple lead teachers, science coaches or other individuals to assist in the leadership of the science departments.

Also and as previously mentioned, Figure 3.1 is a graphical representation of this study where the six individual cases are represented by boxes with two overlapping circles surrounding each cluster of three districts of similar size. As such, Figure 3.1 reveals an assumption for this study. The researcher expected to find some overlapping themes as represented by the area where the circles overlap. He also expected to find some individual case and cluster specific themes. Although this bias could prevent generalization (Verschuren, 2003), it is within reason to be open to learning from all three levels involved in this study design (Creswell, 1998); the individual case, the cluster of cases, and across the two clusters of cases.

Themes within larger urban districts cluster.

Building relationships. Within the cluster of districts with more than 100,000 students, there are several things to learn. Common to all individual cases is the idea that relationship building is important to providing effective professional development. This
theme is slightly different from each individual case. Sandra reported that it is important to build a network of leadership. Even though a dominant and unshared theme for Ellen is *Teach as I Taught*, she knows that she cannot directly impact all of her teachers. So she talked specifically about the need give some people a “push” (Ellen, personal communication, December 18, 2007) or encouragement to get them started. Similarly, Sandra talked about observing teachers who attend professional development offerings in order to identify leaders in her department.

In Susan’s case, the relationship-building theme is a bit less overt. Susan expressed the importance of building a leadership network as an example of her own experience, and she wants more science teachers to have similar experiences. When she talked about her experiences with developing and implementing policy, she was providing an example of how she built herself into a leader and had created a network of her own. Another theme from Susan’s case also relates to building a leadership network. In Susan’s drawing of effective professional development, she illustrates that *Balance* is important. In her interview, she reported that teachers need to learn as both kids and adults learn. Within the learning as adults, she implied that relationships or networking is important (Susan, personal communication, July 17, 2008).

**Immersion experiences.** Each of the informants from districts with more than 1000,000 students also held that certain types of experiences are important to effective science teachers’ professional development. Ellen believes that *Immersion Experiences* in science content are important; she relayed her own stories about her experiences in the Grand Canyon and the Rocky Mountains to make her point. For Susan, science teachers’ professional development experiences have to be balanced not only in the style of
andragogy, but also among content, research, and data. Sandra’s case yields that common starting points for the content of the professional development are important. She believes it to be essential to have common curriculum materials, among sections of a course within a district, and to use content standards to guide science teachers’ professional development.

*Communicating policy change and causing teacher change.* A key learning that emerged from two of the individual cases within this cluster involves themes related to the role that change plays in science teachers’ professional development. An emerging theme from Ellen’s individual case is that for science teachers’ professional development to be effective, it has to cause change for the teacher. Ellen gave advice that science supervisors may not want to initially tell teachers that but causing change has to be the goal of professional development. While Susan handled the role of change a bit differently in her interview as evidenced by her belief that for effective professional development to take place, policy changes must be effectively communicated to teachers. These are two different ways to view the role of change in science teachers’ professional development.

*Teach as I Taught.* As mentioned earlier, Ellen’s individual case reveals an important and unshared theme. The *Teach as I Taught* theme may have been present in other individual cases, but the theme is very noticeable in Ellen’s interview data (Ellen, personal communication, December 18, 2007). As Ellen (personal communication, 2007) said that she was a good teacher, had won an award for teaching, and she wanted teachers to teach as she taught. One reason *Teach as I Taught* is important because of how close it was to “teach as I was taught” (Lortie, 2002).
Maneuver to the money. The important but unshared theme from Sandra’s individual case is the advice for science supervisors to “Maneuver to the money” (Sandra, personal communication, December 20, 2007). Sandra’s interview data reveals that money is important, and she believes that science supervisors who want to provide effective professional development for their teachers need to find a way to fund it. In addition to the interview data, the researcher was also able to observe Sandra taking her whole science leadership team to the English department’s Christmas party. When Sandra invited the researcher to join the party, she remarked that the reason she was willing to merge her party with English was because English had all of the attention and funding due to increased attention resulting from state testing.

Themes within smaller urban districts cluster.

Partners are important. Within the cluster of districts with between 30,000 and 100,000 students, there are several things to learn. The important learning pieces include that partners are important due to each supervisor reporting partners as important to providing effective professional development. Clara thinks of partners in a bit different way from the other two key informants within this cluster. She holds that effective science teachers’ professional development is active and fosters interaction with peers and professionals. In other individual cases, the necessity of partners means someone who provides resources instead of someone with whom to interact. Bonnie relies on philanthropic partners for financial support of professional development and university partners for professional support and facilitation.

Time is important for effective science teachers’ professional development.
Two individual cases yield that elements of time are important for effective
science teachers’ professional development. Clara believes that science teachers’
professional development has to be active and sustained over time, and Bonnie (personal
communication, December 17, 2007) believes that “Even with effective professional
development, progress takes time.”

Listen to partners. There are interesting, unshared themes among the individual
cases in this cluster as well. In Loren’s individual case, there is an odd abandon of
utilizing content standards for guidance. The document review in Loren’s individual case
reveals that university partners are trying to steer Loren’s district to utilize content
standards to create coherence in the science program. From this situation, an unshared
but important theme emerges, which is that the district-level science supervisors are in a
position to listen to advice from the partners, yet may have the latitude to develop their
own direction, which may or may not include best practices. This is different from the
importance of partners because any effort or program could have fantastic partners, but
even with those partners, it is still possible for school districts to miss opportunities to
connect to current best practices.

Value teachers’ time. Clara’s individual case also presented an unshared but
important theme. In Clara’s individual case, she reported several times how important it
is to value teachers’ time. She showed the researcher how she provides required yet
flexible professional development offerings for her science teachers. Clara (personal
communication, 2008) also used phrases such as “of course, the teachers were paid for
their time.” According to Clara, district-level science supervisors and the professional
development they offered would be more effective if they respected teachers’ time.
**Barrier people.** Finally, an unshared but important theme from Bonnie is that barrier people exist. Key informants in each of the other individual cases all report having issues in providing effective professional development and relay that at times, particular people could prevent effective professional development. Bonnie was the only key informant to name this group of folks as barrier people.

**Cross-Cluster Themes**

Each individual case in this study holds specific key learning points. The clusters of individual cases by size also produce specific common and uncommon learning points. It is appropriate to merge some of the within-cluster themes. It is also appropriate to relate some of the within-cluster themes and to identify what could be lost in mergers and comparisons.

**Cross-Cluster Theme: Relationships.** The theme that spans all of the individual cases involves the importance of relationships to effective science teachers’ professional development. The previous section identified how effective relationships are important within the individual cases from the smaller cluster of urban districts, between 30,000 and 100,000 students. In the smaller cluster of urban districts, partners have multiple meanings but are found to be important to effective science teachers’ professional development. Effective relationships are also important to the larger urban districts, more than 100,000 students, cluster. In the larger urban districts cluster, the importance of establishing a leadership network is described and is directly related to the importance of relationships.

The two within-cluster themes can be merged into a major theme: *Effective Science Teachers’ Professional Development Will Establish a Leadership Network and*
Require Partners. This merger is appropriate because both within-cluster themes require the establishment of effective relationships. One important idea that could be lost here was raised through an unshared but important theme. The key learning referenced here is that merely having positive relationships with partners and establishing an effective leadership network will not suffice for effective science teachers’ professional development if a does not have a mechanism to Listen to the Partners (Loren, personal communication, November 30, 2007).

Cross-Cluster Theme: Necessity of Time and Change. This cross-cluster theme emerges from four of the individual cases with two from the larger districts cluster and two from the smaller districts cluster. Both Bonnie and Clara discussed that progress takes time regarding effective professional development. The progress that they are talking about is related to the necessity of change to take place within a teacher as reported by Ellen. What would not be included here would be the role of change as Susan (personal communication, July 17, 2008) described it; policy changes have to be effectively communicated to teachers for effective professional development to happen. This aspect of change falls out of this theme because this theme really means that effective science teachers’ professional development will take time.

Cross-Cluster Theme: Delivery of Effective Professional Development Must Be Guided by Content Standards and Requires Active Immersions in the Field.

This cross-cluster theme comes from a within-cluster theme from two individual cases in the larger district and one unshared theme from Clara’s case. Clara (personal communication, 2008) revealed that effective science teachers’ professional development is active and part of being active, fosters interactions with peers and professionals. Ellen
(personal communication, 2007) enhanced understandings of professional development being active by adding the necessity of immersion experiences. From Sandra’s (2007) case, common starting points were revealed as essential to effective science teachers’ professional development. Those common starting points included content standards.

Conclusion

This chapter presented the data from six individual cases. The key learning points from each informant were presented, and the emerging themes were identified. Within-cluster themes were presented and unshared-but-important themes were also identified. Finally, cross-cluster themes were presented and merged where appropriate. Chapter 5 will further analyze and discuss these themes within the context of the existing literature on effective science teachers’ professional development, and Chapter 5 will present the discussions, implications and conclusions of the study.
CHAPTER 5
Final Analysis, Discussions, & Conclusions

Introduction

This chapter will further analyze the data presented in Chapter 4 by exploring what the data has to offer within the context of the research questions, which will lead to the discussions and conclusions. The final analysis is organized with a brief review the themes from Chapter 4, an analysis of two main categories of the themes, and a discussion of the themes in the context of the research questions. The essential question for the study was: What can district-level science curriculum supervisors add to understanding of effective science teachers’ professional development?

Final Analysis

The emerging themes in this study are from the large urban cluster of districts, the smaller urban cluster of districts, and from both clusters of districts. The following reviews the list of the themes from each:

Themes from Larger Urban Districts Cluster

2. Immersion Experiences.
4. Teach as I Taught.
5. Maneuver to the Money.

Themes from Smaller Urban Districts Cluster

6. Partners are Important.
7. Time Is Important for Effective Science Teachers’ Professional Development.
8. Listen to Partners.


10. Barrier People.

Cross-Cluster Themes


13. Delivery of Effective Professional Development Must Be Guided by Content Standards and Requires Active Immersions in the Field.

Analysis of general categories of the themes. Table 5.1 below organizes the thirteen themes into two general categories. The first general category includes themes that regard personal interactions, and the second general category includes themes that regard elements of effective science teachers’ professional development. As previously mentioned, this study asked fundamental research questions because of the complexity of the phenomenon being studied (Hewson, 2007) and the scarcity of research in the field (Lord, 1994; Spillane, 2000). The thirteen themes generated in this study can be organized many ways. Table 5.1 presents one way to think about these themes and illustrates the related nature of the themes found both within and across the two clusters of districts. Table 5.1 shows the findings as themes listed in two general categories: Personal Interactions and Elements of Effective Science Teachers’ Professional Development.

The first general category in Table 5.1, Personal Interactions, includes seven of the themes generated from the study. It is fairly easy to see the connection for several of the themes listed in the Personal Interactions category (e.g., Building Relationships and
## Table 5.1

*Categorizing the Emerging Themes*

<table>
<thead>
<tr>
<th>General Category</th>
<th>Emerging Themes</th>
</tr>
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<tbody>
<tr>
<td><strong>Personal Interactions</strong></td>
<td>1. <em>Building Relationships</em></td>
</tr>
<tr>
<td></td>
<td>5. <em>Maneuver to the Money</em></td>
</tr>
<tr>
<td></td>
<td>6. <em>Partners Are Important</em></td>
</tr>
<tr>
<td></td>
<td>8. <em>Listen to Partners</em></td>
</tr>
<tr>
<td></td>
<td>9. <em>Value Teachers’ Time</em></td>
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<td></td>
<td>10. <em>Barrier People</em></td>
</tr>
<tr>
<td></td>
<td>11. <em>Relationships</em></td>
</tr>
<tr>
<td><strong>Elements of Effective Science Teachers’ Professional Development</strong></td>
<td>2. <em>Immersion Experiences</em></td>
</tr>
<tr>
<td></td>
<td>3. <em>Communicating Policy Changes and Causing Teacher Change</em></td>
</tr>
<tr>
<td></td>
<td>4. <em>Teach as I Taught</em></td>
</tr>
<tr>
<td></td>
<td>7. <em>Time is Important for Effective Science Teachers’ Professional Development</em></td>
</tr>
<tr>
<td></td>
<td>12. <em>Necessity of Time and Change</em></td>
</tr>
<tr>
<td></td>
<td>13. <em>Delivery of Effective Professional Development Must Be Guided by Content Standards and Requires Active Immersions in the Field</em></td>
</tr>
</tbody>
</table>

*Relationships*). Perhaps less easy to see are the connections of *Maneuver to the Money* and *Barrier People* to the Personal Interactions category. Both *Maneuver to the Money* and *Barrier People* are important components of the Personal Interactions general category because the district-level supervisors revealed that without knowing where the money was or who the barrier people were and strategically seeking out to offset the inherent issues that effective professional development was less likely to occur. Consider Sandra from CSD taking her whole science leadership staff to the English department’s holiday party (Sandra, personal communication, December 20, 2007). She revealed in
her interview that she was showing her support for the English department because she believed that was the department who had the money, which she felt was important to accomplish her goals. She found attending the English department’s party to be so important that she asked to shorten the interview and invited the researcher to attend the party (Sandra, personal communication, December 20, 2007). Likewise, Ellen (personal communication, 2007) from ESD knew that the assistant superintendents in her district held potential to be barrier people so she made a point to set up and attend several meetings with the assistant superintendents. Both examples listed here show that the district-level supervisors strategically maintain relationships with those who stand to either support or hinder professional development efforts. This finding supports the idea that the context of professional development (National Staff Development Council, 2001), as it is situated within a school district, will make a difference in its effectiveness. Further, this finding also supports Elmore and Burney’s (1999) assertion that the professional development be a coherent part of school reform as the two examples provided (Sandra’s and Ellen’s) show actions of district-level science supervisors in which they attempt to align both to the money for professional development and with key people in their districts who can support or hinder the reform efforts.

Another finding related to the Personal Interactions category relates to the importance of partners to effective professional development. While it may not be hard for one to appreciate the importance of partners to effective professional development (Ingvarson et al., 2005), the theme of Listen to Partners confirms, in a unique way, that district-level science supervisors hold power to influence the outcome of reform efforts (Spillane, 2000). Consider that Loren from MSD1 provides an example of a district-level
supervisor who can articulate the rhetoric regarding an initiative (standards), but did not actively attend to the initiative even when the university partners tried to help redirect the attention of the district’s professional development activities to content standards. In this instance, the district-level science supervisor was in a position to move the district forward with successful implementation of standards-based reform, but missed the opportunity based on the view that the professional development associated with the standards-based reform effort was “controversial” (Loren, personal communication, November 30, 2007). Thus, the district-level science supervisors could be barriers to change and reform. This finding is consistent with Spillane’s (2000) assertion that successful implementation of reform will depend on the “broader policy environment, in which the classrooms are nested” (p. 142) as the district-level science supervisors can be a part of that broader policy environment.

There are also fairly easy connections to make among the second general category of the themes in Table 5.1, Elements of Effective Science Teachers’ Professional Development. For example, it is not surprising that issues of time and standards emerge as themes to effective science teachers’ professional development given the focus of time, as the district-level supervisors talked about it, relates directly to the National Staff Development Council’s belief that effective professional development must be completed in context of the participant’s work (National Staff Development Council, 2001), which will obviously require time and a focus on standards. Likewise, all four of the National Science Education Standards on effective professional development (National Research Council, 1996), as outlined in Chapter 1, will require time to mature. Thus, the district-
level science supervisors exercised their new voice in resonance with current understandings and confirmed what was already known in the field.

The three other themes listed in Table 5.1 under the larger urban districts column also held strong connections to the understandings of effective teachers’ professional development. For example, *Immersion Experiences*, which were most directly derived from Ellen’s individual case, relate to several of the NSES (1996) and NSDC’s (2001) beliefs about effective science teachers’ professional development; however, Ellen discussed the importance of immersion experiences that were somewhat outside of the context of teaching. What is meant here is that Ellen’s example of the Grand Canyon trip as a powerful professional development experience was not something that she could replicate in the classroom, but she discussed how that experience showed an importance of reflection in connection with her learning. This point can be taken in two directions; one would be that time for reflection in learning about science concepts is important. The second direction is that reflection is important for learning about how to teach or improve teaching skills; thus providing time for reflection is an important part of effective science teacher’s professional development. This finding not only confirms the need for significant amounts of time for effective professional development (Banilower et al., 2006), but it also confirms that the most useful professional development emphasizes reflection (Darling-Hammond & McLaughlin, 1995).

*Communicating Policy Changes and Causing Teacher Change* is another theme included in the general category of the Elements of Effective Science Teachers’ Professional Development. This theme presents interesting evidence to confirm the importance of district-level personnel to effective professional development (Lord, 1994;
Spillane, 2000) and the importance of context (Borman, 2005). For example, at times the district-level science supervisors were willing to shelve personal beliefs to adhere to all levels of policy as though the policy was more important than the students it was intended to serve (Susan, personal communication, July 17, 2008). However, another district-level science supervisor found her “Cardiac data” (Loren 2007) to be the compass for the direction of professional development in her district and missed important opportunities to make connections to content standards (Midwest School District 1, 2006). This finding confirms that the district-level science supervisors and their understandings of reform efforts are important to the success of the reform effort (Borman, 2005) and illustrates that district-level science supervisors’ apposing philosophies create the situation for their potential influence as “street-level bureaucrats” (McLaughlin, 1987; Weatherly & Lipsky, 1977) who definitely can influence the successful implementation of reform (Spillane, 2000) in either a positive or a negative way.

Finally, a startling and perhaps worrisome finding included in the second general category of themes is that of Teach as I Taught. The present study has only scratched the surface of what this theme may contain. As mentioned in Chapter 4, this theme is close to “teach as I was taught” or “the apprenticeship of observation” (Lortie, 2002), where the danger is that it is unclear as to what kind of teacher the district-level science supervisor was when they were in the classroom, and they could be championing effective or ineffective teaching practices. Further, if it is a pervasive trait of district-level science supervisors to desire that teachers teach in the same way that they taught, then it stands to reason that research should be conducted to find out more about what
kind of teachers the district-level science supervisors are. This brings to mind several questions: What teaching methods did the district-level science supervisors utilize when they were in the classroom? What are the best ways to teach science according to the district-level science supervisors? What do the district-level science supervisors recall as the major obstacles to effective science teaching? Depending upon the answers to these questions, the district-level science supervisors could be seeking very different outcomes for the science teachers in terms of professional development. This finding again confirms that district-level science supervisors beliefs are important to successful implementation of reform efforts (Borman, 2005; Spillane, 2000).

**Analyzing the themes in context of the research sub-questions.** Another way to understand the data presented in Chapter 4 is to examine how the themes relate to each sub-question. Table 5.2 illustrates the relationship of themes to research sub-questions and how some themes help to answer more than one sub-question. Table 5.2 presents a simplistic reduction of the themes and data presented in Chapter 4 and identifies that each theme has important connections to at least one of the research sub-questions.

**Sub-Question 1: How do district-level science supervisors perceive and describe their experiences with teachers’ professional development?** Table 5.2 shows that five of the themes relate to the first sub-question. The theme mentioned previously in the categorical analysis, *Teach as I Taught*, helps to answer this sub-question because the desire for her teachers to teach as Ellen (personal communication, 2007) taught could influence the types of professional development that she would be willing to champion in her district. Another useful theme that relates to this sub-question is *Building*
Relationships. For example, Sandra (personal communication, December 20, 2007) of CSD and Ellen (personal communication, 2007) of ESD discussed that building relationships is important for building capacity for future leadership. Closely related to the relationships theme, the district-level supervisors also confirmed that partners are important to effective professional development (Ingvarson et al., 2005), not only in their

Table 5.2

Relating the Themes to the Research Sub-Questions

<table>
<thead>
<tr>
<th>Theme</th>
<th>Research Sub-Question</th>
</tr>
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<tbody>
<tr>
<td>1. Building relationships</td>
<td>✓</td>
</tr>
<tr>
<td>2. Immersion experiences</td>
<td></td>
</tr>
<tr>
<td>3. Communicating policy changes and causing teacher change</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>4. Teach as I taught</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>5. Maneuver to the money</td>
<td>✓</td>
</tr>
<tr>
<td>6. Partners are important</td>
<td></td>
</tr>
<tr>
<td>7. Time is important for effective science teachers’ professional development</td>
<td>✓ ✓ ✓</td>
</tr>
<tr>
<td>8. Listen to partners</td>
<td>✓</td>
</tr>
<tr>
<td>9. Value teachers’ time</td>
<td>✓</td>
</tr>
<tr>
<td>10. Barrier people</td>
<td></td>
</tr>
<tr>
<td>11. Relationships</td>
<td>✓</td>
</tr>
<tr>
<td>12. Necessity of time and change</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>13. Delivery of effective professional development must be guided by content standards and requires active immersions in the field</td>
<td>✓</td>
</tr>
</tbody>
</table>
words, but also in their actions. Consider that Michelle (personal communication, December 17, 2007), Ellen (personal communication, 2007), and Sandra (personal communication, December 20, 2007) each had the researcher for this study meet with partners they perceived as important to their professional development efforts. The group of people that the district-level science supervisors perceived as important included professional development providers, science coaches, and university partners. Thus, this finding supports the belief that considering professional development as a process [emphasis added] is essential for success (Greensfeld & Elkad-Lehman, 2007; National Staff Development Council, 2001) because meaningful partnerships with these individuals will take time to develop.

The final theme that helps to answer the first sub-question relates to the district-level science supervisors’ perceived importance of time. Figure 5.2 shows that time is an important theme that relates to all of the sub-questions. The finding that time is important should not be surprising given teachers, which each of the district-level supervisors once were, have historically believed that they lacked the necessary time to accomplish the goals of education (Sizer, 1984).

Sub-Question 2: What value do district-level science supervisors ascribe to their experiences with professional development for science teachers? 2a. How do district-level science supervisors define effective professional development? 2b. How do district-level science supervisors define ineffective professional development? As previously mentioned, conducting research on effective professional development is difficult because of the complexity of what is being studied (Hewson, 2007). In a similar way, understanding the perspectives of the district-level science
supervisors is difficult because they, too, are complex (Borman, 2005). Figures 4.1 through 4.9 contain a host of information that helps to identify what the district-level science supervisors in this study believe about effective and ineffective professional development. As Thomas et al. (2001) show with their study, the participant drawings themselves can provide data sufficient for an entire study. Due to the of the amount of data and the potential for learning about what the district-level science supervisors believe about effective and ineffective professional development, the drawings will be utilized in connection with the themes to help answer this research sub-question. The analysis of the participant drawings here differs from the presentation of the data in Chapter 4 by directly comparing the sets of effective and ineffective participant drawings from each cluster of districts. The participant drawings are organized into four figures: two figures of effective professional development participant drawings and two figures of ineffective professional development drawings.

**Effective professional development drawings.** The district-level science supervisors revealed several positions and helped illustrate their definition of effective professional development in Figures 5.1 and 5.2.

The words are a bit challenging to read in Figure 5.1. Ellen titled her drawing as “Effective PD [Professional Development],” and the other words are “Facilitator and Instructions.” As presented in Chapter 4, Susan included “Content, research, instruction and activities and data” (see Figure 5.1). Sandra chose to include “Student achievement, HQ T/L [high quality teaching/learning], coherence, teacher quality, and more support policy” (see Figure 5.1). The words in the drawings (see Figure 5.1) confirm that content, context, and process are important components of effective professional
development (National Staff Development Council, 2001). The words in the effective professional development drawings from the large urban districts (see Figure 5.1) are also consistent with the studies reviewed in Chapter 2, which revealed content, active learning, context, coherence, and partnerships as important components of effective professional development (Banilower et al., 2007; Garet et al., 2001; Ingvarson et al., 2005). This finding is evidence that the district-level science supervisors’ understandings of effective professional development are consistent with what is known in the field.

Interestingly, Sandra was the only district-level science supervisor to include student achievement as a portion of the effective professional development drawings in Figure 5.1, which is consistent with the overt suggestion from Fishman et al. (2003) to
link professional development and student achievement. Perhaps Ellen and Susan assumed student achievement to be an integral part of effective professional development, but they did not make explicit reference to student achievement in their drawings (see Figure 5.1). This begs the questions: Do district-level supervisors perceive the importance of linking student achievement to all professional development experiences? Or, when and in what ways would it not be appropriate or possible to link student achievement to professional development experiences? These questions come to mind especially when thinking about Ellen’s (2007) espousal that the immersion experiences are important.

The drawings included in Figure 5.1 from the large urban districts cluster yield an initial definition of effective science teachers’ professional development by the district-level science supervisors: Effective science teachers’ professional development includes opportunities for collaboration, reflection on practice, support, coherence with context in one’s job, an appropriate balance of research, content, data, and activities for learning with an underlying goal of increasing student achievement. This finding is largely consistent with current understandings of effective professional development from the field (Banilower et al., 2007; Garet et al., 2001; Ingvarson et al., 2005; National Staff Development Council, 2001); however, certain evidence supporting this finding shows that the district-level science supervisors may have at least two nuances to consider in the field, which will be further discussed in the implications portion of this chapter.

Figure 5.2 presents the juxtaposition of the effective professional development drawings from the smaller urban district’s cluster. The words included in Figure 5.2 are “Higher Ed. [Education], Special Ed. [Education], and Gen. [General] Ed. [Education],”
from Loren (see Figure 5.2). “Teacher, P.D. [Professional Development] Provider, what are you finding out?, Teacher, Standards, Discussion/Application of lab,” all under

“Task/Problem,” as a heading for Michelle, and Clara added, “Effective and P [Presenter]” (see Figure 5.2). Also, Clara’s arrows represent two-way communication where the exchange of ideas must be an iterative process between and among the
facilitator(s) and participating teachers (Clara, personal communication, January 30, 2008).

Given the emergence of the theme *Listen to Partners* as previously discussed, it is interesting that Loren chose to include multiple professional development providers working in collaboration because that inclusion confirms the understandings of effective professional development from the field (Ingvarson et al., 2005). However, this finding was not consistent with her interview (Loren, personal communication, November 30, 2007) or the document review (Midwest School District 1, 2006) as previously mentioned.

Given the additional words and illustrations of interactions with multiple people that can be seen in Figure 5.2, the definition of effective professional development as derived from district-level science supervisors participating in this study is updated as follows: Effective science teachers’ professional development includes opportunities for iterative and open collaboration among participating teachers and facilitators, reflection on practice, support from both policy and partners, coherence with context in one’s job, and an appropriate balance of research, content, data, and activities for learning with an underlying goal of increasing student achievement. This finding remains consistent with the current understandings from the field (Banilower et al., 2007; Garet et al., 2001; Ingvarson et al., 2005; National Staff Development Council, 2001).

**Ineffective professional development drawings.** It is often times helpful when defining something to examine what it is not. Figures 5.3 and 5.4 are the participant’s drawings of ineffective professional development for science teachers. Only Ellen and Susan have drawings included in Figure 5.3 because Sandra chose not to complete two
drawings. The words in both Figure 5.3 and Figure 5.4 are discernable and limited, so the areas of focus to start with are the similarities within the drawings in each figure.

Both Ellen and Susan show one facilitator working with teachers (see Figure 5.3). One difference in the drawings from the large urban districts is that Susan shows the teachers with their heads down on the table and not engaged at all, while Ellen shows the teachers with something in their possession and a smile on their faces (see Figure 5.3). In the small urban districts’ drawings of ineffective professional development, Michelle drew a smiling professional development provider (see Figure 5.4). However, Ellen from the large urban districts’ drawings of ineffective professional development was the only participant to reveal the participating teachers’ faces (see Figure 5.3). As previously discussed, the smiles on the faces of the teachers in Ellen’s portion of the drawing are likely the “PD Junkies” (Ellen, personal communication, December 18, 2007) that she believed were happy to go to any professional development offering for a few dollars and were not really interested in professional learning. This finding adds a nuance to current understandings considering that the field understands that active participation is
necessary for effective professional development (Garet et al., 2001). If this phenomenon would play out for large numbers of participants in multiple professional development

Figure 5.4. Small urban districts’ ineffective professional development drawings.
setting, “PD Junkies” (Ellen, personal communication, December 18, 2007) could impact reform efforts and possibly skew professional development research. This finding could be significant for studies that rely solely on teachers’ self-reported data.

Each of the ineffective professional development drawings from small urban districts used a single unidirectional arrow to represent the direction of communication of the message from the professional development experience (see Figure 5.4). Chapter 4 discussed that ineffective professional development will have a unidirectional message, which appropriately represents the opposite of the necessity of iterative communication (Clara, personal communication, January 30, 2008) for effective professional development revealed earlier. To examine further, notice the arrows in all four figures (see Figures 5.1-5.4). In Figure 5.1, Susan used the arrows to point directly at the facilitator to represent the importance of balancing all the important areas of input, whereas the arrows in Figure 5.4 all point away from the presenter. Consider the Teach as I Taught theme from Ellen’s individual case and the inherent dangers discussed (Lortie, 2002); it appears that the participating district-level science supervisors understood that unidirectional, message-giving types of professional development are not effective, at least with andragogy. Thus, this finding from the district-level science supervisors provides visual evidence to support the understanding that effective professional development must have active learning where the participants engage in collaborative discussion regarding the content (Banilower et al., 2007; Blank & de la Alas, 2009; Garet et al., 2001; Ingvarson et al., 2005).

Given these findings, the district-level science supervisors’ definition of ineffective professional development is: Something that is completely individual in both
delivery and learning opportunities, not engaging even though participants may have materials, and an experience that may even be enjoyable by the participant without regard to effectiveness. As previously mentioned, this finding is mostly consistent with current understandings of effective professional development sans the possible effects of the “PD Junkies” (Ellen, personal communication, December 18, 2007).

Sub-Question 3: What can district-level science supervisors tell us about the origins, intended goals, or visions for science teachers’ professional development versus the actual outcomes of science teachers’ professional development? 3a: In what ways can the barriers to effective professional development for teachers be overcome? Again, this question is a basic starting point to add the district-level science supervisors’ voice to the literature. Table 5.2 shows that three of the themes relate to more than just the third research sub-question. The themes that relate to at least one other sub-question are: Communicating Policy Changes and Causing Teacher Change, Time is Important for Effective Science Teachers’ Professional Development, and Necessity of Time and Change. As was previously discussed, the findings from these three themes yielded that the supervisors mostly confirmed that effective professional development had to be considered a process (Greensfeld & Elkad-Lehman, 2007; National Staff Development Council, 2001).

Table 5.2 also shows that the four themes that relate only to the third research sub-questions are Maneuver to the Money, Listen to Partners, Barrier People, and Value Teacher’s Time. In the analysis of general categories section earlier in this chapter, the first three themes listed here were found to confirm the idea that the context of professional development (National Staff Development Council, 2001). The one theme
that has not yet been discussed is *Value Teachers’ Time*, which was found from Clara’s individual case. The reason that *Value Teachers’ Time* helps answer research sub-question 3 is because the field understands that to be effective professional development must actively involve the science teachers for 60-80 hours (Banilower et al., 2006). However, if the teachers do not feel that their time is valued and that they are supported, they will disengage with the professional development and the success of the effort can be diminished (Clara, personal communication, January 30, 2008). This finding confirms that district-level science supervisors can be stabilizing allies in reform efforts (Banilower et al., 2006).

The finding that the district-level science supervisors can be stabilizing allies to reform efforts is one of the slightly deeper levels of understanding that emerges here in that science supervisors hold significant power as policy is reified into practice through professional development offerings because of their position (Spillane, 2000). The finding that the district-level science supervisors hold significant power in influencing the intended vision and reform goals as they develop into actual professional development experiences is related to the idea that the district-level science supervisors are “street-level bureaucrats” (McLaughlin, 1987) in a highly bureaucratic system (Tyack, 1974). For example, on the surface most of Loren’s rhetoric was consistent with best practices for professional development in that the offerings need to be standards-based for content and delivery, but the document review uncovers that there was an abandon of standards as a guiding force in providing professional development in MSD1 (Midwest School District 1, 2006). After the researcher went back to the data, he viewed her “Cardiac data” (Loren, personal communication, November 30, 2007) comment in a new light.
She revealed the significant influence that she held in determining what actually happened for professional development in her district. This emerging issue of power was previously discussed as important, especially when district-level science supervisors like Ellen (personal communication, 2007) intend to have teachers teach the way that she taught.

**Central Question: What can district-level science supervisors add to the understandings of effective science teachers’ professional development?** As argued earlier, the district-level science supervisors’ voices are missing from literature on effective professional development. This study sought to add their voice to the literature and sought to add to understandings of effective professional development. While it is apparent that the district-level science supervisors’ voices were explored in this study, the perspectives of the district-level science supervisors yields findings that mainly just confirm many understandings of effective professional development. However, there are a few potential nuances found in this study that show that the district-level science supervisors may serve as a good check for other research findings just as other groups of administrators and central office staff have for other studies (Banilower et al., 2006; Dutro et al., 2002; Franke et al., 2001). The nuances to current understandings of effective professional development suggested by the district-level science supervisors include issues of power, duration, student achievement, and “PD Junkies” (Ellen, 2006).

**Strengths of the Study**

This study sought to learn more about how district-level science supervisors perceived and described effective science teachers’ professional development. The definition of effective science teachers’ professional development derived from an
analysis of the responses of district-level science supervisors was that effective science teachers’ professional development includes (a) opportunities for iterative and open collaboration among participating teachers and facilitators, (b) reflection on practice, (c) support from both policy and partners, (d) coherence with context in one’s job, and (e) an appropriate balance of research, content, data, and activities for learning with an underlying goal of increasing student achievement. Further, that professional development may be enjoyable by the teacher without regard to effectiveness. Thus, *PD Junkies* likely represent a portion of the participants who are surveyed in studies regarding effective science teachers’ professional development where teacher participant survey data is the only source. With this small caveat, these definitions largely confirm current understandings of effective professional development (Banilower et al., 2007; Garet et al., 2001; Ingvarson et al., 2005; National Staff Development Council, 2001).

Another strength of this study was that it provides specific evidence about how district-level science supervisors think about professional development. The researcher was able to learn through interviews, observations, document review, and participant drawings how the informants viewed effective professional development. In most cases, the researcher was able to confirm what was found in the interview data. In a few instances, mismatches were found among the data sets and were discussed. The geographical distance and separation of informants also provided a rich pool of informants with diverse backgrounds. Finally, the similarities of the drawings in some cases were striking, and the drawings led the researcher to deeper understanding of the district-level science supervisors’ perspectives of effective science teachers’ professional development.
Implications

The purpose of this study was to gather information from six district-level science supervisors to gain a deeper understanding of effective professional development. The central research question for this study was: What can district-level science supervisors add to the understandings of effective science teachers’ professional development? In answering the research questions, a definition of effective science teachers’ professional development was derived and, as previously mentioned, that definition related to and provided confirming evidence to commonly held beliefs about professional development. As Spillane (2000) viewed the district-level leadership positions as an essential yet under-researched component of professional development, the district-level science supervisors proved to be individuals with direct, yet complex (Hewson, 2007) understandings of professional development. Though those definitions were stated and the answers to the research questions were provided, there were also several deeper-level issues that emerged, which were only barely touched on by this study. Two of these deeper-level issues include the connection of student achievement to professional development and a deeper issue of duration.

Student achievement and professional development. The definition of effective professional development derived from the district-level science supervisors in this study included an “underlying goal of increasing student achievement.” At first glance, this could seem consistent with the imperative to link student achievement to research on effective professional development (Fishman et al., 2003). However, the district-level science supervisors in this study may have been pushing back on the Fishman et al. (2003) imperative to link student achievement to research on the
effectiveness of science teachers’ professional development. There was some motivation to provide professional development without the need to see immediate gains in student achievement (Ellen, personal communication, December 18, 2007).

This could appear counterintuitive at first glance, but consider that the professional development experiences could take place over several months and the students concurrently with the teachers may not show immediate gains. Also, Ellen expressed her views of effective professional development by talking about two of her own personal experiences in immersion-style activities (Ellen, personal communication, December 18, 2007). The benefit that Ellen talked about was regarding the time for reflection (Ellen, personal communication, December 18, 2007). Considering that reflection, as Ellen was talking about it, is an ex post facto situation, the opportunity to have a positive impact on the current year’s crop of students may have already passed. Also, consider how Sandra (personal communication, December 20, 2007) maneuvered to the money to get past barriers for effective professional development. That action suggests a realization that effective professional development will take time to materialize and requires overt efforts to align with several stakeholders and the money. Thus, immediate impacts on student achievement may not always be discernable, which is consistent with the complex nature of professional development and its research (Hewson, 2007).

**Duration and professional development.** Another area that the participants in this study were pushing back on research was in the duration of effective professional development. Banilower et al. (2006) found 60-80 hours for a professional development experience to be the most effective. In many ways, the district-level science supervisors
confirmed the need for appropriate amounts of time for effective professional development; however, they also challenge this notion. For example, the district-level science supervisors challenge the understanding that effects of professional development minimize after 80 hours (Banilower et al., 2006) as they look more holistically at the course of the teachers’ careers and had a bigger view of professional development that included more than one event or one series of events. The Banilower et al. (2006) study focused on the National Science Foundation’s Local Systemic Change Initiatives where participants were required to complete 100-130 hours of professional development for each project. Banilower et al. (2006) noted that the duration with the maximum impact was 80 hours, after which they didn’t see much return for longer duration. What the district-level science supervisors in this study seem to suggest is that research regarding professional development could be structured to include a more holistic examination of the life work of teachers and their involvement with multiple and varied professional development opportunities which supports the understanding that effective professional development is a process (National Staff Development Council, 2001).

**Future Studies**

Understanding the effectiveness of teachers’ professional development is difficult and complex (Hewson, 2007). As such, this study was designed to answer fundamental or seminal research questions. Although the researcher answered those fundamental questions, there remain a host of areas ripe for further research. For example, each of the participants included in this study held fascinating viewpoints and insights into teaching,

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2 Consider that two of the within district themes dealt with time and one of the three major cross-cluster themes was *Necessity of Time and Change* for professional development to be effective (see Table 5.2).
learning, and professional development. Susan’s individual case especially could have served as an entire case study with her experience of implementing reform issues at the federal level coupled with her first-hand working knowledge of large public school systems.

The researcher’s potential bias also provides direction for future study. He utilized his experience as a district-level science supervisor to establish rapport with the participants in the study. In doing so, he could have unknowingly led the conversation in different directions than would have otherwise been followed. Using the interview protocol was an effort to guard against this bias, but the limitation still exists. It follows that future qualitative research should include interviewers who are not district-level science supervisors, and the approach could be improved by utilizing a team of interviewers.

Future studies should also consider developing an instrument that identifies what the district-level science supervisors believe. The argument was made that the qualitative approach utilized in this study, including obtaining data through interviews, observation, document review, and participant drawings of professional development, was appropriate to initially explore the district-level science supervisors’ perspectives (Merriam, 1998). Although continuing with this appropriate research is necessary as this study was limited to only six individual cases, a new direction of research should include quantitative measures where the district-level science supervisors be surveyed to identify patterns in beliefs.

This recommendation to consider the utilization of survey data and quantitative methods stems from the Teach as I Taught theme where it was determined that at least
one of the six participants in this study was motivated to see teachers teach as she taught when she was in the classroom (Ellen, personal communication, December 18, 2007). This theme was discussed as being close to dangers associated with the “apprenticeship of observation” (Lortie, 2002). Finding out how Ellen taught was slightly outside of the scope of this study, but she presented an interesting paradox. Understanding the beliefs of district-level science supervisors also becomes important considering the finding of this study that the district-level science supervisors are in a position of considerable ability to influence reform efforts, which is consistent with the message from both Spillane (2000) and Borman (2005). It stands to reason that the stakeholders who are interested in advancing Science Technology Engineering and Mathematics (STEM) initiatives in large public school systems would be interested to understand the beliefs of the district-level science supervisors as this study confirmed that the district-level science supervisors can be stabilizing allies in reform efforts (Banilower et al., 2006).

**Conclusion**

This dissertation is a story about science supervisors’ perspectives of effective professional development that was conducted based on the argument that current understandings of effective science teachers’ professional are missing important voices. The key informants for this dissertation were district-level science supervisors. The National Staff Development Council (NSDC) espoused that effective professional development must be results driven or related to process, standards embedded or related to content, and job embedded or related to context (National Staff Development Council, 2001). The NSES provided the following professional development standards: (a) continuous inquiry, prior knowledge or learning science; (b) integrating content,
pedagogy, and students or learning to teach science; (c) life-long learning with feedback and reflections or learning to learn; and (d) continuously coherent and integrated or quality programs at all levels (National Research Council, 1996). The findings of this study add the district-level science supervisors’ voices to understandings of effective professional development. Studying the district-level science supervisors has contributed to understanding professional development by confirming the understandings of the importance of relationships, the power, and influence of the district-level science supervisors in a de facto bureaucratic system (Tyack, 1974).

The major finding of this study is that the district-level science supervisors largely confirm what is already known in the field of professional development research. One main confirmatory finding includes that the district-level science supervisors’ beliefs are important to the success of implementation of reform efforts and to the success of professional development offerings (Lord, 1994; Spillane, 2000). Further, as the goal of this research was examined – to explore what the district-level science supervisors could add to understandings of professional development – a few nuances to current understandings developed and emerged even though the findings are mostly confirmatory. For example, now that the district-level science supervisors’ voice has been initially explored, one next step could include quantitative measurements of the supervisors’ beliefs and relate these beliefs to their effectiveness. Though it is not possible to generalize in qualitative research (Verschuren, 2003), the findings in this study reveal extreme and somewhat apposing philosophies among the six participants. It stands to reason that a quantitative instrument could be developed that could sort the districts based on the beliefs of the district-level science supervisors. Once sorted by
believes, it would be interesting to then examine students’ science achievement, which would provide a link back to the imperative of Fishman et al. (2003) to link studies of professional development to student achievement.
References


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Appendix

Interview Protocol
Interview Protocol

Thank you for taking the time to talk to me today. I will be audio-recording this interview and taking notes while you share your story. It is very important that my writing accurately reflects what you mean. I would like you to review my writing to ensure that it represents your views. I will send you the case summary upon completion for your review.

I am interested in adding district-level, curriculum supervisors’ voices to the literature regarding the utility of professional development. You have had the chance to review the questions that I am going to ask and give them some thought. I am really interested in your perspective so please feel free to discuss your views. I may ask some additional questions as we go through this process that you have not seen. Are you ready to begin?

1. Can you tell me a little about yourself and how you came to your current position? (Probes: What led you to become a district-level, curriculum supervisor? What other positions did you hold? In what ways were the previous positions helpful? Why this district, why this position?)
2. From your perspective, what makes professional development effective for teachers? (Probes: What constitutes “effective” to you with regard to professional development? How would you define “professional development”? Are your ideas influenced by anyone or anything? What are your goals of professional development for science teachers in your district? Why are these goals important? Are they consistent with others’ goals in your district? Are they consistent with science teachers’ goals in your district? Why or why not? What purpose does effective professional development serve for science teachers in your district?)

3. What are some examples of current professional development activities for science teachers in your district? (Probe: Could you describe some of the recent or on-going specific activities your teachers are engaged in?)
4. As you think about your experiences with teachers’ professional development, what comes to mind? (Probes: Where did the ideas for this type of professional development for science teachers in your district come from? What were the positive aspects? For you? For teachers? For students? What were the negative aspects? For you? For teachers? For students? What happened over time? For you? For teachers? For students?)

5. Could you talk a little about the conclusion of those experiences? (Probe: Have these experiences led to any new ones? If so, how did it happen? Any relationships forged, strengthened, etc. or contact maintained?)
6. When you think about your teachers’ professional development experiences, how do you describe the specific skills/abilities that your teachers acquired through particular professional development activities or more generally?

7. When you think about these experiences, what pieces are unique to your district? (Probes: What is unique to your district? What does one need to consider when setting up and offering professional development for science teachers in your district? What do you think would be different about the PD offering if the professional development was offered for teachers in another district? In rural districts? Or in districts smaller than yours?)
8. If you were using a metaphor to describe effective professional development for science teachers, what would it be? Explain what you mean. (Probes: What images come to mind when you think about offering professional development to science teachers in your district?)

9. In what ways have teachers’ professional development activities impacted science education in your district? (Probes: Teachers’ teaching, students’ learning, curriculum, assessment, etc.)
10. Sometimes we gain a lot from examining ideas in different ways. Would you mind drawing two pictures for me? One that depicts your version of effective professional development for science teachers, and another that depicts your version of ineffective professional development for science teachers?

11. Talk to me about your pictures.
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<td>12. Is there anything that I haven’t asked you about that you think I should know to understand your work in this district?</td>
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<td>13. I would like to ensure that I have an accurate picture and understanding of the context in which you work as well as an accurate understanding of your views of the utility of professional development. I had previously sent you a list of possible documents that may help me construct a clearer picture of your work. I would like to collect any of those that you may have at this time; however, I also know that the interview and the site visit can prompt you to direct me to more documents or people that may help me with the context descriptions. 1) Can you send me any additional documents that you believe may help me? 2) Who else do you think I should talk to?</td>
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